SAE JOURNAL

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APRIL
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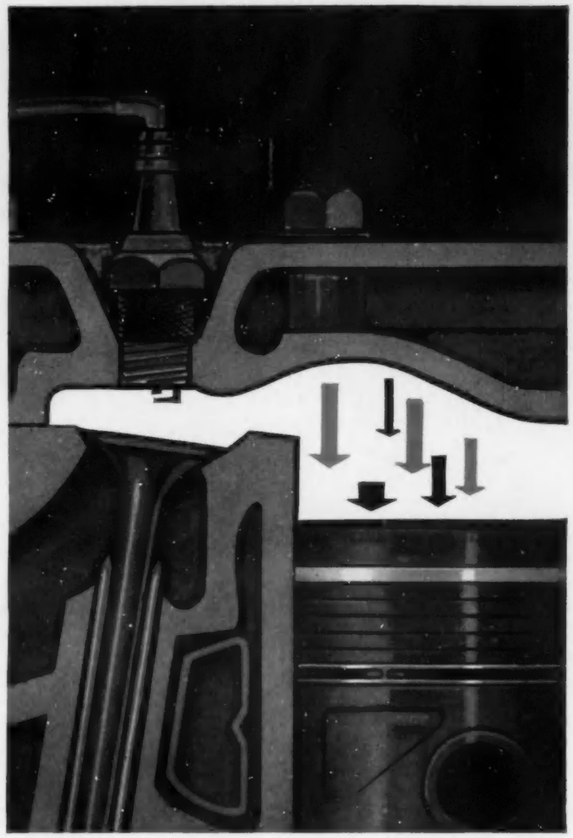

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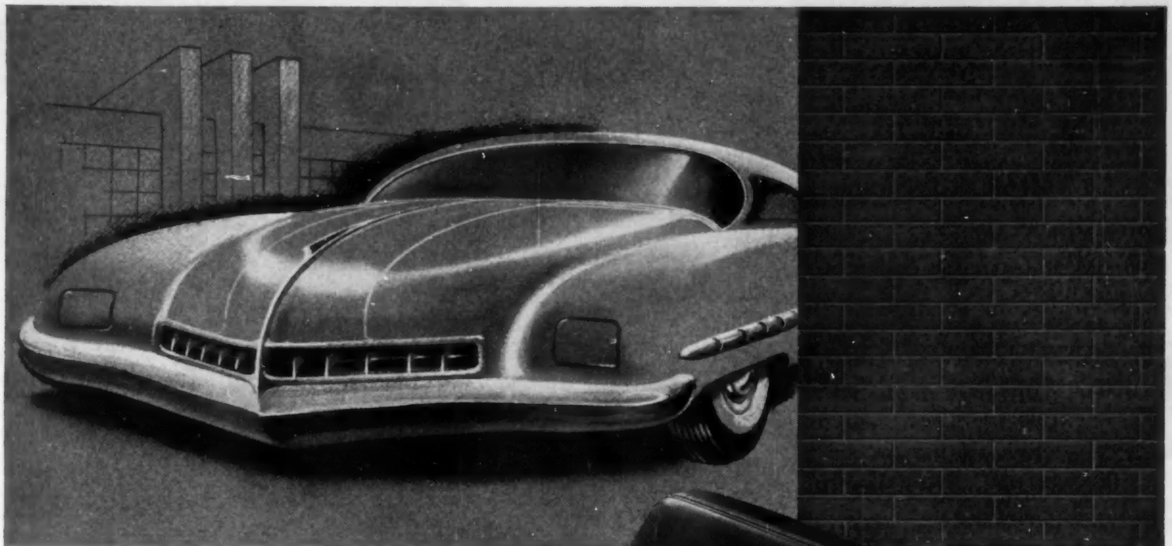


We tie truck axles in

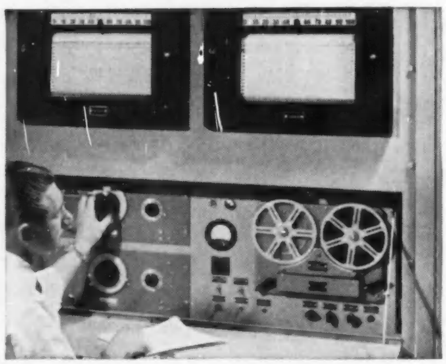
in the new Timken-Detroit indoor proving ground . . . and only

We twist, shock-load, abuse, and torture them. Match every conceivable hauling condition. Then add a few brutal tricks of our own!

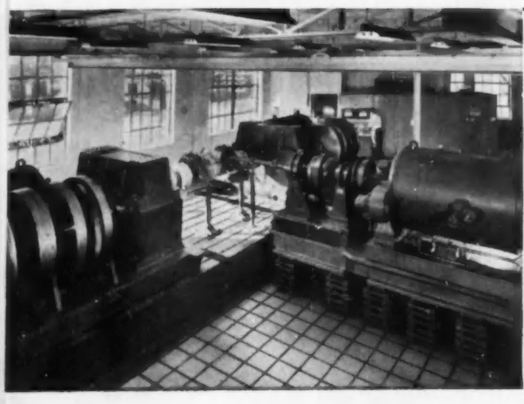
Why? So you'll know in advance, and *for sure,* that a Timken-Detroit axle can take the punishment it was designed for. More rugged, grueling punishment than any other axle made!

To prove it, we capsuled a multi-thousand acre proving ground into one room. Here our engineers can put 50 years of experience in building axles for trucks, buses and trailers to work—subjecting axles and gearing *indoors,* to any *outdoor* operating condition.

Such exacting research pays off in longer axle life; less maintenance, repairs and downtime; reduced operating expenses. This is why Timken-Detroit axles are preferred by truck builders and owners everywhere.



This is our "truck driver." He works in our "Torture Chamber." Above him are graphs showing speed and torque performance under any operating condition he chooses . . . soft ground at full load . . . mountains . . . express highways or side roads. With special dials, recorders and electronic devices, he actually *drives* the axle with scientific accuracy from his chair!



How TDA proves axle quality in this "Torture Chamber"

We pick one of our axles at random . . . then duplicate a hauling condition, hour after hour, day after day . . . simulating half a million miles of the toughest driving situations in just a few days. Or "invent" a test like going uphill with a full load from California to New York nonstop. There is no other axle testing like it in the world!

For highway hauling Timken-Detroit axles are best. Identical axles in our indoor proving ground are subjected to tests so rugged—they're comparable to a half-million miles or more of high-speed, non-stop, uphill-downhill operation with capacity load . . . hour after hour, 24 hours a day, for days! Only Timken-Detroit "Torture-Tested" axles can take this brutal treatment—to assure top performance—make operators more money per load!

Heavy hauling on all kinds of roads—that's rough on axles—but nothing compared to what we do in the TDA Indoor Proving Ground. For instance, we take an axle shaft and twist it 14° forward and backward, 36 times a minute, 24 hours a day, week after week. Or simulate the punishment an axle housing would get hitting a chuck hole with a capacity load, every 4 seconds, 24 hours a day, month after month!

knots

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TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

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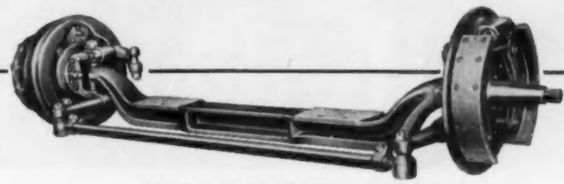
to Save Money on the Job

WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS



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Here is easy, positive steering control. A little man can handle a large rig with TDA front axles as easily as a big 210-pound, six-footer, at fast or slow speeds...on smooth or rough roads. No wheel kickback. Tractor semi-trailer hook-ups have smallest possible turning radius—greatest maneuverability.

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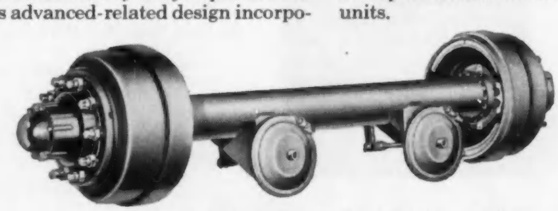

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Plants at: Detroit, Michigan
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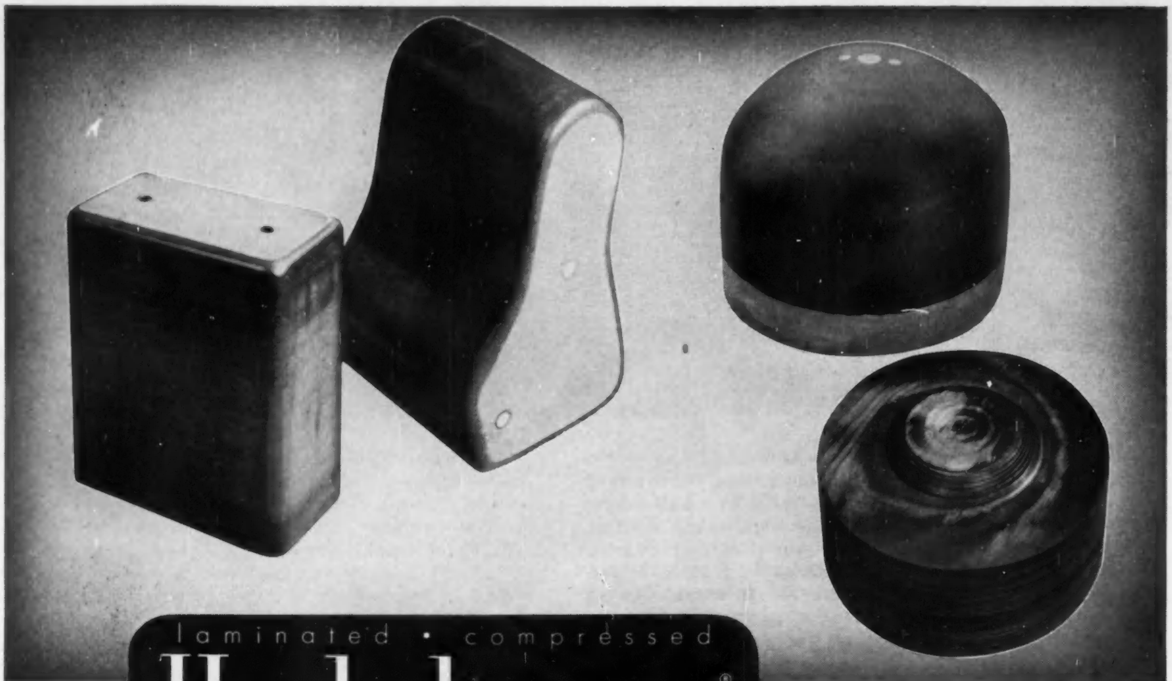

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"made-to-measure" density

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For the spinning block illustrated, the material proved so easy to work that the tool was made by a spin lathe operator at North American Aviation's Columbus, Ohio, Division plant, instead of by a toolmaker.

Whatever your sheet metal tooling needs may be, for short or long run production, Hy-du-lignum is the die stock material you should use. It meets all requirements for large or small diameter.

There are many uses for Hy-du-lignum

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- Drill and Router Blocks
- Sub-Assembly, Spot Weld Fixtures, etc.
- Layout Boards
- Tube Bending
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- ***Form dies for hand-lay-up or rubber bag molding reinforced (glass) plastics.***

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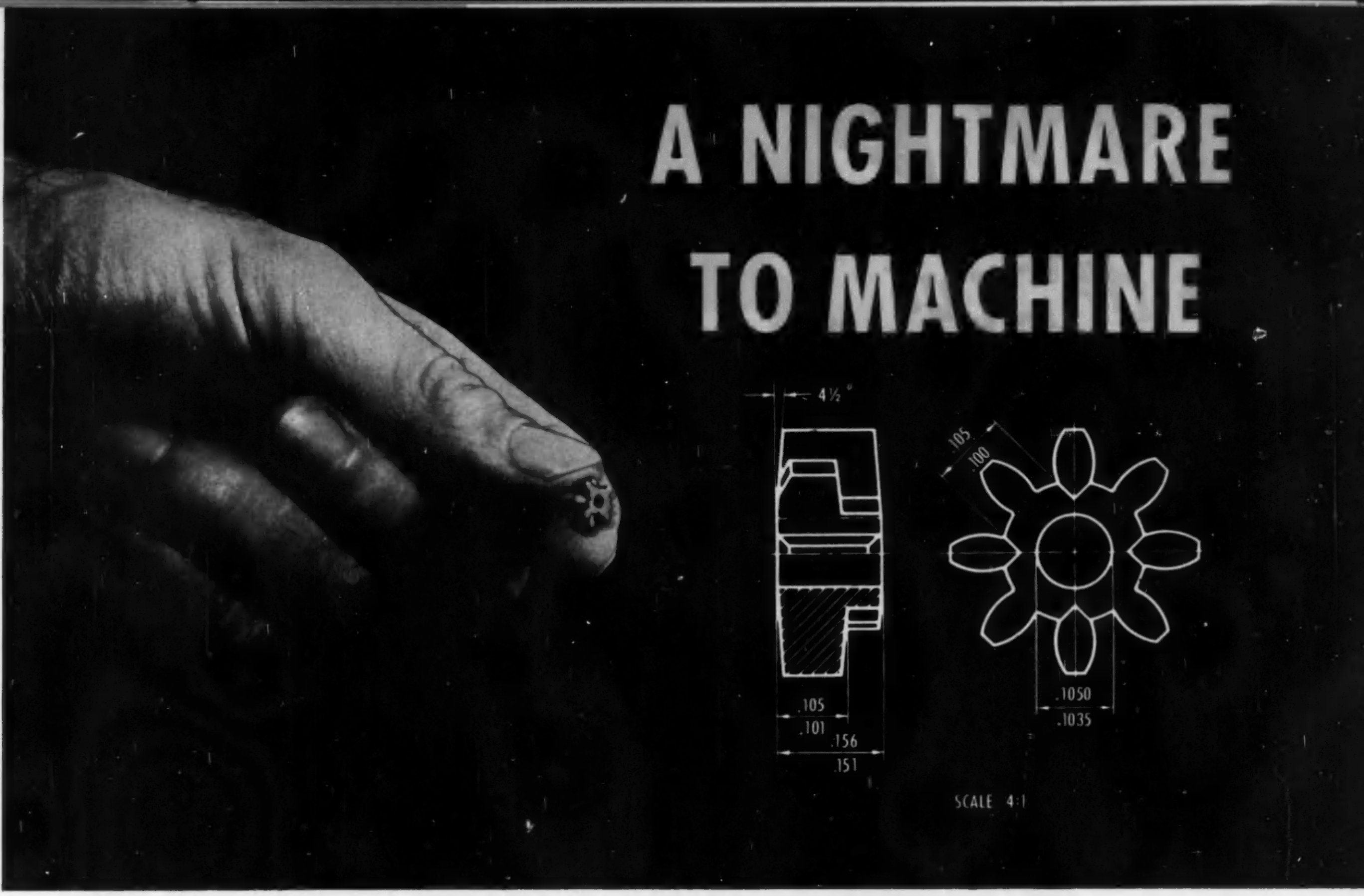
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SCALE 4:1

For the Sake of Argument

"We Are What We See . . ."

By Norman G. Shidle

An SAE member, the other day, said he views the future of a new powerplant "with an open mind and a degree of optimism."

The American Rocket Society says that ARS has always maintained "an optimistic attitude" on the probability of space flight in this century.

This engineer seems likely to do more for this powerplant than an equally-equipped confrere with a dim view of its future. . . . And so with the American Rocket Society and its contribution to space travel.

Plato was thinking along these same lines two thousand years ago, when he said what might be modernized as: "We are what we see."

To accomplish anything, we must first conceive the possibility of accomplishment. And every one of us tends to habit formation in this respect. Seeing good possibilities may become chronic—or taking a dim view may get to be a fixation. In the latter spiral, it's all too easy to rationalize that the results aren't worth the effort. (Sometimes, of course, they're not!)

But seeing good possibilities has its rewards as well as its achievements. The man with an open mind and a degree of optimism attracts new ideas from associates. They let him in on untried ideas they aren't ready to prove. New projects are likely to be born in his presence. People come to know he will never choke a newcomer with preconceived standards, prejudices or pride.

The man with an open mind and a degree of optimism is pretty welcome company to anybody, anywhere, anytime.

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Contents—April, 1954


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Industry Hushing Exhaust Noise To Meet Regulatory Demands for

QUIET TRUCKS

REGULATORY authorities are ready to lower the boom on noisy trucks. Fear of technically unsound regulation plus recognition that trucks *can* be made quieter has stirred up a three-way scramble for exhaust noise relief among fleet operators, truck builders, and muffler makers.

Each one acknowledges the room for improvement in his area, and is doing something about it, but feels the other two are hindering him.

- The fleet man says that some truck companies still give him noisy, short-life mufflers and he has to face punitive action by highway administrators.
- The truck engineer blames some of the noise on poor driving techniques and "gutting" of mufflers by drivers. He also feels there's room for improved muffler design.
- The muffler designer claims that truck engineers don't allow enough room for a big enough muffler to quiet engine exhaust.

What's encouraging today is that there's greater recognition of the other fellow's problem and each is doing more to shoulder his fair share of the noise-reduction job.

1. Regulatory Crackdown

And it's high time too, many agree, for antinoise agitation is snowballing. In some communities elected officials are running on "quiet-the-truck" planks. It's growing increasingly popular to push truck noise legislation.

Administrators are tired of waiting for more research and getting excuses as to why trucks haven't been quieted, says L. C. Kibbee, American Trucking Associations. They are about to act, he reports, even if what they do isn't technically best. Enforcement people can't understand why some trucks seem quiet while others are noisy, despite similar operating characteristics. They are becoming less sympathetic to arguments that elaborate and extensive research is still needed to lick truck noise.

Some highway officials are already searching for a noise-measuring instrument for use by police. No one in the trucking industry is happy about this prospect. In fact, one state right now is said to be ruling trucks off the highway on the basis of an ordinary "applause meter."

2. Why the Noise

No one in the industry denies that some trucks now on the road are noisy. But ask why they're so and you run into a combination of reasons, some more technical than others . . . . from criticism of quality, design, and operating methods to lack of adequate test tools.

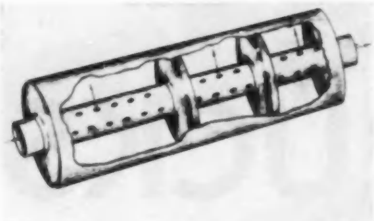
Operator R. L. Hardgrove says original equipment mufflers are bad enough, but replacement jobs are even worse. Replacement muffler vendors stress

This article is based on four papers and discussion of them presented at the SAE National Transportation Meeting, Chicago, Nov. 3, 1953. The papers and their authors are:

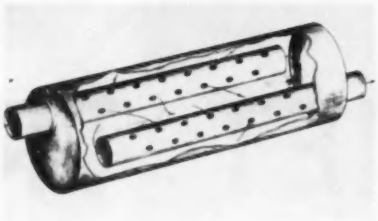
- **"Commercial Vehicle Exhaust Noise—Its Cause and Cure . . . Problems of the Truck Operator," by R. L. HARDGROVE, The Liberty Highway Co.**
- **"Commercial Vehicle Exhaust Noise—Its Cause and Cure . . . from the Vehicle Manufacturer's Viewpoint," by B. F. JONES, Autocar Division, The White Motor Co.**
- **"Commercial Vehicle Exhaust Noise—Its Cause and Cure . . . Problems of the Muffler Manufacturer," by C. E. NELSON, Nelson Muffler Co.**
- **"Exhaust Noise and Back Pressures versus Engine Operation," by M. L. FAST, Cummins Engine Co.**

These papers are available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ each to members; 60¢ each to nonmembers.

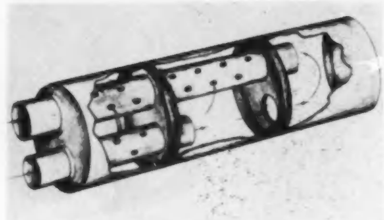
Three Muffler Types



Straight-Through Muffler



Two-Pass Muffler



Return-Flow Muffler

Basically, acoustic muffler designs fall into two categories—the straight-through and return-flow types. (The return-flow design is a variation of the two-pass type.)

The straight-through muffler is usually unsatisfactory for low frequencies. The inner muffler tube is merely an extension of the exhaust and tailpipe. In the return-flow type, the exhaust and tailpipe are offset, so there is an alternate path for the gas to follow. This produces an out-of-phasing effect and reduces the low and intermediate notes as well as the higher frequencies. The return-flow design also transfers more heat from the exhaust gases to the muffler than the straight-through type.

either low back pressure in their mufflers or heavy-duty construction. The low-back-pressure models usually are "gutless wonders" with very low back pressure and a high noise level. The heavy-duty construction mufflers are often heavy and noisy.

Autocar's Chief Engineer B. F. Jones feels poor truck operation is as much a noise factor as inadequate muffling. Many noise complaints are levelled against impatient drivers who persistently "gun" their vehicles and create an exhaust roar. Others knock out the baffle plates in a muffler on a mistaken supposition that this will increase the horsepower at the wheels. Poor maintenance which allows the exhaust line to become defective also contributes to the noise picture.

Muffler maker C. E. Nelson claims no one has yet come up with a good way of silencing engine exhaust without using the proper volume inside the muffler. The larger the engine, the larger must be the exhaust system, and, in turn, the larger must be the muffler volume to reduce pressure variations to an acceptable level.

Jones admits that muffler size is the bugaboo of the truck designer. Legislation limiting overall vehicle length has forced the truck manufacturer to shorten the chassis wheelbase. That has brought the cab-over-engine vehicle with its wider cab. It's tough to mount a muffler alongside the cab while still maintaining a vehicle width of 96 in.

Present-day transmissions, auxiliary transmissions, fuel tanks, and battery boxes also intrude on the muffler.

Even if most of these noise-causing troubles are remedied, the noise problem won't be completely licked. And for this one big reason: No one has yet come up with an entirely suitable way of measuring noise. So there is no real way of comparing the noise from one truck with that from another, except to say "This one *sounds* noisy to *me*; this one sounds quiet." And that means that noise is still pretty much a subjective reaction. Without a yardstick, you can't come up with a standard of acceptable noise level.

Trouble with most currently used noise-measuring devices, says Jones, is that they record vibration only, and measure total noise or intense low-frequency sound.

If present instruments and a jury of listeners were stacked against each other in noise tests, meter readings and jury judgment would coincide for only about 60% of the tests. That's because the jury is adversely affected by high frequency noises and even more by intermittent noises, which can't be measured by instruments.

A new meter may soon be available which correlates more closely with jury judgment. It will have three frequency bands that show low, medium, and high frequencies. But this instrument won't be good for enforcement purposes because of the complicated method for registering sound levels.

Engineers also are unhappy about techniques for measuring exhaust back pressure. They say the manometer does not read exhaust back pressure until it becomes great enough to become an almost static pressure.

3. Strides Being Made

Despite the kaleidoscope of noise causes, the industry is making trucks quieter. New knowledge, recognition of old problems, and actual redesign are achieving results.

Muffler makers are helping the truck designer find

the best construction for each particular requirement. They have been able to adapt acoustic muffler design to shape of space available by furnishing long, skinny mufflers, or short, fat ones.

L. H. Billey, Donaldson Co., tells truck engineers that muffling is nothing more than correction of exhaust flow. He says the easiest noise to muffle is one having a sine wave of uniform amplitude and frequency. A noise with a square wave of nonuniform frequency and amplitude is the most difficult. So improvements in exhaust A.M. (amplitude modulation) and F.M. (frequency modulation) will bring more useful power from the energy fed into the engine.

Billey notes that the rear outlet exhaust manifold of an engine is bad from an F.M. standpoint. A V-8 engine, with either two pipes or a cross-over to one pipe, is the worst condition. To correct it, he suggests that the passage from each port be of equal area and distance to the exhaust pipe flange. This also should be done with the intake manifold to assure equal amounts of air to each cylinder.

Coiling fuel injection tubes in diesel engines provides equal distance from pump to nozzle. It's an example of an attempt to control F.M. and A.M. Although this kind of approach may be impractical for an exhaust manifold, Billey feels it merits investigation. Since unequal distances are the cause of bad F.M. and A.M., such an exhaust manifold would do as good a job of silencing as an average muffler does today.

The square wave comes from too many high-frequency side bands superimposed on the firing frequency. High-frequency sounds result from too much velocity or too-abrupt velocity changes at valves and valve ports. The harmonics are a function of overall exhaust system length, or geometrical configurations such as distances to or between elbows, location of muffler, and length of tailpipe.

Billey also advises that exhaust stack diameters need attention. A 4-in. O.D. exhaust pipe is too small for a 300-hp, 6-cyl, 2100-rpm engine.

Truck manufacturers are putting more and more emphasis on exhaust noise suppression. They are shooting for an exhaust noise level that's not noticeably above the engine, fan, wheel, or windage noise produced by the vehicle in motion.

To do this, they are trying to match engines with compatible mufflers. They realize that each type engine has a characteristic sound pattern; the exhaust system has to be synchronized with this pattern to get acceptable noise levels. Failure to do this in the past produced poor installations.

Truck engineers also are aiming for adequate proportions in the exhaust system to get back pressures which will not rob engine power.

Diesel mufflers have been designed to operate at about 1 in. hg back pressure for naturally aspirated engines, up to about 1½ in. hg for supercharged units. Gas and propane units are satisfactory at around 2½ to 3 in. hg.

C. E. Nelson reports that vehicle builders are going to larger mufflers. One manufacturer increased the size of his muffler by five times. Another is redesigning his cab to allow for an adequate muffler. And still a third has increased muffler size by two to three times for his new models.

Since larger mufflers will cost more to replace,

How Exhaust Back Pressure Creates Noise

The pressure wave set up by the sudden release of high-pressure gas by exhaust-valve opening is the basic cause of exhaust noise, explains M. L. Fast. This pressure wave has a very sharp front. So it can excite all parts of the exhaust system, regardless of their own natural frequency.

These pressure waves occur at all operating speeds and loads. The amplitude is mainly affected by load.

At certain speeds, the number of pressure waves will correspond to the natural frequencies of the column of gas in the exhaust system. These resonance periods are quite noticeable when the engine is accelerated throughout its speed range. That's one of the major problems in designing a satisfactory muffler.

The pressure waves also will be transmitted to the atmosphere through the exhaust system walls. This is usually called shell noise. It's due to forced vibration of the containing walls of the exhaust manifold, exhaust pipe, and muffler.

Leaks in the exhaust system are another source of exhaust noise transmission . . . leaking manifold gaskets, split or burned out exhaust pipes or mufflers.

Excessive back pressure manifests itself in two ways:

1. Increased friction horsepower which reduces the engine's mechanical efficiency. (The piston has to work harder to expell exhaust gases from the cylinder.)

2. Diluting and increasing the temperature of the incoming air, which reduces the pounds of air available for combustion in the engine.

If excessive back pressure is permitted for any considerable time, engine service life will suffer. Troubles like these will show up: (1) warped or burned exhaust valves; (2) manifold cracking and increased oxidation; (3) burned head and manifold gaskets; (4) burned and sticking pistons and rings; (5) possible cracking of cylinder heads; and (6) increased carbon and sludge in the crankcase.

ways of increasing muffler life are getting serious consideration. Aluminized steel, stainless steel, and ceramic-coated metals are being tested. Where weight isn't critical, heavier metal has been used in mufflers.

4. Reports from Truck Companies

To determine specifically what is being done by truck builders, B. F. Jones contacted the top engineers of truck companies. The following are excerpts from some of the reports he received:

● GMC Truck and Coach Division, General Motors Corp. **C. J. Bock**, Chief Engineer:

New models for 1954 will have the noise level of the exhaust reduced to the general noise level of the truck. It is felt that this will eliminate most of the complaints now being registered.

To accomplish this we would have to increase the volume of the muffler and pay more for it. But we feel it must be done if we are to keep good public relations for the trucking industry. Mufflers have been increased in volume considerably for both gas and diesel vehicles. No mounting difficulties have been encountered.

Our noise jury feels that new muffler sizes do a creditable job of silencing our vehicles, and that if the exhaust systems are properly maintained there will be few, if any, complaints.

● International Harvester Co., Motor Truck Division: **W. D. Reese**, Manager of Engineering:

At present two investigations are being conducted concurrently: One deals with the methods of recording engine exhaust noise on magnetic tape for jury appraisal of various exhaust systems. The other is a basic analysis of the effectiveness and efficiency of various muffling concepts.

The study of recording techniques has included roadside exhaust noise recordings of moving vehicles, of engines equipped with a standard exhaust system operating on a dynamometer, and of a moving vehicle with the recording equipment mounted on the vehicle.

We have reason to believe that much of the annoyance factor in exhaust noise results from the higher frequencies (100 cps and up), which are not harmoniously related. As yet, few firm conclusions can be drawn regarding noise abatement: However, as we progress into this field the facts will dictate the course of further study and permit a logical evaluation of the problem.

● Mack Mfg. Corp. **F. R. Nail**, Assistant Chief Engineer:

During the past five or six years, considerable work has been done to find the best answer to these requirements, and progress can be illustrated by the following examples:

a. Trucks and tractors with 200-hp diesel engines: We are now using an 8½-in. diameter by 35-in. muffler with acceptable results. As further improvement, we have now developed an 8½ by 60-in. muffler of the interrupted-flow type, which has affected a 30% reduction in noise level. No increase in back pressure and no sacrifice in life of muffler has been experienced, although cost is considerably higher.

b. 200-hp gasoline engine: Change has been made from a 6½ by 32-in. return-flow muffler to an 8½ by 30½-in. return-flow muffler with a 3½-in. inlet in place of a 3-in. one. Noise level has been improved and life of muffler has been increased, due to use of stainless steel interior and heavier metal gage. Controlled service installations have recorded mileages over 200,000 as an index to the endurance.

c. 165-hp gas engines. Only change found necessary or desirable has been to increase diameter of inlet from 3 to 3½-in. This has reduced back pressure and increased durability.

d. On large COE models with 200 to 275-hp diesel engines, we have developed a new 6 by 14 oval section muffler, 60 in. long, porcelanized, of the interrupted-flow type. Noise characteristics indicate objectionable levels are 50% lower than with former 8½ by 35 round muffler.

e. 170-hp diesel. We are using the same muffler as for the 200-hp gasoline engine with excellent results.

● Peterbilt Motors Co. **E. S. Ross**, Chief Engineer:

Unless the diameters of mufflers go to excessive sizes, there is not much improvement in the reduction of noise levels. If the mufflers are made 10 or 12 in. in diameter, it will be impossible to mount the mufflers in a practical manner.

A muffler with both inlet and outlet at the same end, located on brackets under the frame side rail is practically impossible to install because of interferences from battery boxes, tire carriers, fuel tanks, and other chassis parts.

In the COE models, it has been necessary to mount the vertical muffler on the side of the cab in a cove in the cab, itself, to keep within the 96-in. width limit. This would be practically impossible with a 12-in. diameter muffler.

To protect the driver from burns, it has been necessary to install a guard around the muffler, which again increases the diameter.

● Diamond T Motor Car Co.: **R. C. Wallace**, Executive Engineer:

Volume has the greatest effect in silencing mufflers. On one of our units using the 200-hp diesel, we have gone to a 9-in. diameter by 45-in. long unit. This has been accepted as good on the Pacific Coast.

On our gasoline units, we try to stay at around 2-in. hg of back pressure or less, and still maintain a relatively low sound.

We are very conscious of the public's reaction on noise, and are setting up to run a complete recheck on our whole muffler program. It should be possible to develop a standard muffler location for diesels, as there are some states which will not permit vertical stacks and others which require them.

● Brockway Motor Co., Inc.: **R. S. Reed**, Chief Engineer:

In lessening the exhaust noise, care must be taken not to restrict the muffler, which will result in raising the back pressure with loss of power in the engine. An alternative is the use of a larger muffler, or twin mufflers, and, again, this brings up the question of difficulty in mounting—particularly on short-wheelbase tractors.

It would seem that a muffler—to be quiet without too much back pressure—would require so much space that the only place to mount it would be on top of the cab.

It seems necessary that muffler manufacturers come up with a device that's quiet, efficient, and occupies a very small amount of space.

● Kenworth Motor Truck Corp.: **R. C. Norrie**, Chief Engineer:

With the continually increasing horsepower required for the various trucks, the additional space required for the muffler must be taken away from either the body space or the driver. In our COE design, we have found it necessary to put a pocket in one corner of the cab to provide space for the muffler.

We have also tried to increase the life factor of our exhaust systems by using aluminum coated steel.

● Autocar Division, White Motor Co.: **B. F. Jones**, Chief Engineer:

Recent investigations and tests of a number of muffler types have resulted in the adoption of a larger muffler than the one formerly used. This has materially reduced objectionable noise previously experienced, and has also

resulted in lower back pressure. However, tests and research are being conducted in our laboratory and on the road, in an attempt to further reduce the noise level, to that of other sounds given off by a vehicle on the highway.

- Reo Motors, Inc.: **W. M. Walworth,** Vice-President in Charge of Engineering.

We have recently released as a special equipment item a quieter muffler than our standard unit. Our standard unit is 6-in. in diameter by 22-in. long, and the special unit is 7-in. in diameter by 24-in. long.

From a jury noise level standpoint, the larger muffler results in a 30 to 35% reduction in noise level. This is obtained with a penalty of only ½-in. hg in back pressure. We are hesitant to say that this muffler carries the noise level down to passenger car quietness, as, to date, we have not found a muffler that will do so.

Explosion Testing . . .

. . . of fuel boost pump throws light on explosion hazard. New procedure developed to permit designing aircraft equipment on "designed safe" basis prior to fabrication.

Based on paper by **W. K. Klose** Boeing Airplane Co.

IN explosion testing to determine the safety of equipment for airplanes, certain aspects of explosion phenomena are often overlooked. This was brought home to Boeing when a fuel boost pump under compliance test unexpectedly ignited the external explosive mixture. Accordingly, a thorough study was made of flame travel through restricted openings which involved laboratory testing.

In the test setup, two interconnected bombs were so arranged as to permit insertion of a flame suppressing device between two explosive mixtures. The devices used in a series of tests were metal plugs of various lengths with a single drilled hole through the center of each plug. The effect of both ignition location and fuel-air ratio could then be observed.

The vent hole sizes used in the original pump had been found to be 100% unsafe in the laboratory test. Since the laboratory setup permitted very accurate control of conditions, it was felt that five occasions of flame travel through the pump in actual test proved the laboratory test truly represented the degree of safety which could be expected from hole size and length relationships used in the pump. Fig. 1 presents graphically the hole sizes established as safe and unsafe.

Following additional study, Boeing has established a new procedure for explosion proof qualifications, more detailed than normal, which reflect such items as mixture ratio, ignition location, and temperature. The requirements are such as to permit the equipment manufacturer to approach the design of new equipment as "designed safe" prior to fabrication. Thus far, necessary changes in equipment to qualify under the new procedure have been slight, and by and large manufacturers have welcomed having a way to approach equipment on a "designed safe" basis.

(Paper "A New Concept of Explosion Testing of Aircraft Equipment" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953. It will be published in full with discussion in the 1954 SAE Transactions. It is also available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers).

Based on Oral Discussion

F. A. Jennings, North American Aviation, Inc.: Did ignition ever occur in cases where no visible flame but only hot exhaust gases passed through the hole?

Klose: No evidence of such ignition was found.

Jennings: Were multiple small holes satisfactory as flame suppressors?

Klose: Yes.

R. E. Gorton, Pratt & Whitney Aircraft, Division of United Aircraft Corp.: Is there any reason for the apparent importance of the location of ignition source with respect to flame-suppressor holes?

Klose: Literature led us to believe that it must be caused by the fact that gas molecules in the immediate vicinity of the point of ignition attain considerably higher temperature than those removed from the ignition source.

M. Belzer, North American Aviation, Inc.: Is there any effect of baffles in the chamber?

Klose: We have no information on this.

F. E. Lenherr, Northrop Aircraft, Inc.: Can quench-distance theory predict hole size?

Klose: Our understanding of this theory is limited. We found ourselves at a loss as to a means to include the effect of pressure drop across the opening since the theory was evolved to predict quenching under a constant-pressure burning condition not typical of aircraft applications.

VENT HOLE SIZE CHECKED		
DIAMETER	LENGTH	RESULT
0.0810	2.06	□
0.0995	2.06	■
0.1100	2.06	■
0.1200	2.06	■
0.1250 *	2.06	■
0.0625	.68	□
0.0781	.68	■
0.0939 *	.68	■
0.0465	.25	□
0.0625	.25	■
0.0783 *	.25	■
0.0465	.18	□
* DIA. OF ACTUAL HOLES IN PUMP		

□ SAFE
■ UNSAFE

Fig. 1—Showing the comparison of pump vent holes which tests established as safe with those which were originally in the fuel boost pump

How Quality Control Touches and Gives

THE greater understanding constantly accorded to quality control in automotive plants is attested by expert opinion at two SAE Production Forum panels on this subject. Both at Milwaukee last September and Toronto last October quality control was redefined and evaluated. Currently, it appears, quality control:

1. Is a joint effort of all company departments to coordinate their activities;

2. A method which assists in making the best possible product at the lowest possible cost;

3. Is "the right material processed properly";

4. Points the way to improvement in manufacturing, tooling, inspection, and engineering;

5. Is not a cure-all for all manufacturing aches and pains, but a strongly-recommended remedy.

And it doesn't matter too much to whom quality control reports, as long as it helps to improve quality, up production, and cut costs.

Aids Engineering

Quality control relations with the engineering group are important among the many contacts it has throughout the organizations it serves. QC methods on "probability-thinking," for instance, are of potential value to the engineers. These methods can help them with problems of interpreting laboratory performance data and setting design tolerance.

A QC group can make a number of studies to assure engineering that a particular part has the proper specifications and that it can be made according to the drawing. These studies may include such steps as:

1. Analyze the part to know what tolerances are necessary;
2. Evaluate the process under which the part is to be manufactured to determine if the proper tooling is available;
3. Specify gaging on the drawing to eliminate arguments between manufacturing and inspection as to how and where the part should be checked;
4. Assure engineering that gaging is available to measure accurately the part to be produced;
5. Request that only important dimensions be placed on the drawing.

Engineering-manufacturing attitudes differ on the last of these five points it was recognized. To engineering, all dimensions are important because they provide the area, volume, or specifications a part is to have or to which it must conform. But what's important to manufacturing will vary in different cases.

Parts made from mill stock, for instance, (rounds, squares, hexagons, structural shapes, etc) need only show the work done on the part, as the initial geometry has already been set by standards. . . . But parts made from forgings pose a different problem. Too often, forging and casting dimensions appear on the same drawing. Though related, they can cause unnecessary checking in inspection of the final machined piece, as well as confusion in manufacturing. So, many companies are adopting separate drawings for forgings, castings, and machining.

Some help comes from classifying dimensions as major and minor. Major dimensions may be those having close tolerances related to mating parts. Minor dimensions may be those which do not affect function or application.

Further argument about tolerances brought out a majority opinion at Milwaukee in favor of bilateral as opposed to unilateral tolerances. And,

Everywhere –

Help Everywhere It Touches

L. O. Laabs, Le Roi Co.
C. R. Burdick, Houdaille-Hershey Corp.

Based on reports of two secretaries at two Panels on Quality Control at SAE Production Forums. Mr. Laabs was secretary of the Panel at the SAE National Tractor Meeting in Milwaukee, September 14, 1953. Mr. Burdick, at the Panel at the International Production Meeting in Toronto, October 29, 1953

it was said, "taper" and "out-of-round" must be identified and isolated as such before the question can be answered: "How much of the tolerance can be used by 'taper' and 'out-of-round'?" Engineering tolerances usually include these variables and before they can be controlled, the ability of the process to hold within total tolerance must be known.

Likely to Cut Inspection Costs

In most cases, quality control tends to cut inspection costs as well as improve quality. Only occasionally will it increase inspection costs by revealing a product not up to required specifications.

It tends to reduce inspection costs by:

1. Studying machine processes and capacities to determine if a part can be made to specifications;
2. Using sampling plans to reduce unnecessary inspections;
3. Using drawings indicating only important dimensions;
4. Encouraging the worker to produce good pieces and to take pride in his work;
5. Making available sufficient and satisfactory gaging.

When an inspection operation must allow no defects, several special requisites to successful quality control application appear. Important among them are:

1. Manufacturing must be capable of producing a good product;
2. Costs will be increased when the risk is increased;
3. Engineering must design in a certain amount of safety area;
4. The so-called 100% inspection will be 300 to 400%, because the piece usually will be 100% inspected during the processing.

Putting a QC program into a receiving inspection department is entirely feasible, but involves special considerations. All purchased items, for example, should be inspected in the receiving department, and the inspection being performed by vendors should be determined clearly. The vendor and the receiving inspection group should agree on what the vendor is to inspect for.

An acceptable sampling plan is needed, too, to keep defective material entering production to a minimum. Types of defects for which inspection is to be done should be classified, also. Also, records should provide a history of inspection performance on a particular vendor's product and the types of defects found.

Quality control is, in short, a common sense approach to all kinds of inspection problems. It aids particularly in giving the inspection department data so that correct decisions can be made.

Works Well on Short Runs

Because the operator will usually take many measurements during a short-run job, quality control can readily be applied. If he will just take the small additional effort to record his measurements, a very complete set of statistical records of machine process and capacity can be had. By these records, it can be determined if the piece is being produced

economically—and whether additional tools, gages, jigs, or fixtures are needed.

Applies to Visual Inspection

Quality control can be readily applied to visual inspection, too. To do so, scratches, dents, acid marks, splash and other defects must be charted. Rework and scrap must be recorded as well, and pictures and samples should be provided for comparison by the workers and inspectors. All of these actions will aid supervisors in giving inspectors necessary training.

QC and the Foundry

Two approaches are possible to quality control of a foundry operation. The finished casting can be analyzed, the defects recorded, and the record studied to determine what caused the defects. . . . This is working backwards to the first process used in producing the casting.

Or, it can be assumed that the foundry knows how to produce an acceptable casting. Then, the quality control program would be set up to control the process from the start to the finish.

QC and Assembly Operations

Applied to assembly operations, QC usually is used differently than when applied to manufacturing processes. Average and range charts are used, however, in variable measurements such as torque, timing, and piston fit. P and C charts are used to show the variation from hour to hour, day to day, and the long-range change. . . . If variation from standard continues for any appreciable length of time, the record is placed on an assignable-cause report and sent to top management, so that corrective action may be taken.

How to Install QC

Quality control can be successfully installed either by qualified members of an existing organization or by consultants brought in for the purpose. If a company has several plants, it is probably best to have a central installation source until the program gets under way. Later, a decentralized QC operation may be best.

Large organizations are more likely than small ones to have staff personnel capable of setting up a program. It needs men trained in statistical quality control—but not necessarily college graduates nor trained engineers. It needs men able to help everybody in the plant understand the objectives of the QC program.

When consultants are required, management should never hire them just to be able to say to customers: "Oh, yes, we have a quality control program." Management must really be ready to take the action necessary to install and operate a good quality control program.

The time a consultant needs to complete an installation varies, of course, with the size and complexity of the plant operations. In a small company, the installation might well be completed in six months. In larger companies, it could run five years or more in some instances.

In any case, the simpler and more practical a QC system is made, the better are the results to be expected. . . . And to keep a system sold and clearly understood, many believe, the QC group should keep talking to management in terms of dollars—and to manufacturing in terms of quality.

Quality control, they believe, should be considered first as a defect-preventative. Cost reduction should be considered an important by-product.

(The reports on which this article is based are available in full in multilithographed form from SAE Special Publications Department. SP-303 is a complete secretaries' report of the seven panels of the 1953 SAE Tractor Production Forum; price: $1.50 to members, $3.00 to nonmembers. SP-305 is a complete secretaries' report of the eight panels of the International Production Forum; price: $1.50 to members, $3.00 to nonmembers.)

TWO QUALITY CONTROL PANELS . . .

. . . last Fall talked of common problems, developed information which was both complementary and supplementary. This article is a synthesis of the reports of the two revealing discussions which were lead by the following experts:

The Tractor Meeting Panel

R. S. Saddoris, Leader, A. O. Smith Corp.

L. O. Laabs, Secretary, Le Roi Co.

F. Holbik, J. I. Case Co.

E. Schiesel, Mattatuck Mfg. Co.

Ralph Brown, Minneapolis-Moline Co.

C. P. Dewus, International Harvester Co.

The International Production Meeting Panel

J. C. Knapp, Leader, Ford Motor Co. of Canada

C. R. Burdick, Secretary, Houdaille-Hershey Corp.

A. Bender Jr., Delco-Remy Division, GMC.

J. D. Gardiner, Massey-Harris Co., Ltd.

D. H. W. Allan, The Steel Co. of Canada, Ltd.

J. N. Berrettoni, J. N. Berrettoni and Associates

B. H. Lloyd, Canadian Industries, Ltd.

N. G. Meagley, Willys Motors, Inc.

Jet Fuel Systems Needn't Be So Complicated

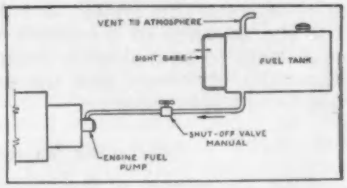


Fig. 1—Light planes get by with this . . .

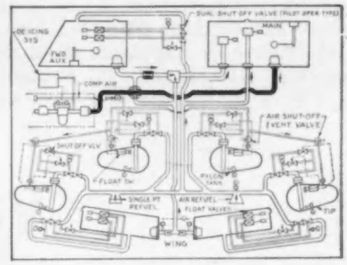


Fig. 2—But look at what jet fighters get

R. R. Higginbotham and W. R. Petersen,
Republic Aviation Corp.

Excerpts from paper "Fuel System Complexity—How Much Is Necessary?" presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 1, 1953.

FUEL systems of military aircraft are too complex. This doesn't mean that all of the requirements which they must meet are unnecessary or undesiraable. But some of them are. And still others could be met in far more simple fashion.

To be more specific, unnecessary fuel-system complexity arises from designing for full performance on 7-lb fuels, and providing an emergency fuel system, extended inverted flight coverage, and an alcohol system for filter de-icing.

Perhaps the best way to appreciate the complicated nature of current aircraft fuel systems is to compare one with the simplest possible aircraft fuel system. Such a system (see Fig. 1) consists of a single tank with a fuel-level gage, and a tube running from the tank to the engine through a manual shutoff valve. Hundreds of light airplanes are flying with just such a system, and it is entirely adequate for their requirements.

By way of contrast, look at the schematic diagram of a fuel system with air refueling provisions for a typical jet fighter. (See Fig. 2.) A considerable increase in the number of tanks, lines, and components is immediately apparent. Moreover, this schematic indicates only the wiring necessary to associate certain shutoff valves with the corresponding float switches. If the complete electrical wiring of the system could be shown on an illustration this size, the diagram would appear even more formidable.

The gap between these two fuel systems is too great to bridge in a single step. For that matter, while a few of the complicating requirements can and should be eliminated, others are either unavoidable or justified by increased safety or tactical utility. In the case of those which cannot be eliminated, the logical course would be an attempt to accomplish the same results by simpler means.

What Contributes to Complexity

Before taking a look at what can be done, let's see what factors contribute to fuel-system complexity . . . and how they do it. Principal promoters of complexity are the requirements for:

1. Multiple internal tanks
2. Automatic fuel-tank sequencing
3. Vapor suppression
4. Extended aircraft range of operation
5. Auxiliary fuel systems
6. Filter de-icing
7. Emergency fuel system
8. One minute of inverted flight
9. Air refueling
10. Single-point pressure refueling

The best way to show how these factors contribute to fuel-system complexity is to take the simplest system for a given tank arrangement and build it up.

Multiple Internal Tanks

Fig. 3 shows the simplest system that can be used with multiple internal tanks. About the only differ-

ence between this system and the one shown in Fig. 1 is the addition of a selector valve which permits each tank to be manually connected to the engine. Naturally, however, this increases the number of fuel level gages required.

Automatic Sequencing

With the advent of the turbojet engine, and the inherent higher fuel flow rates and less warning of fuel starvation, it was decided that manual tank switching would lead to too many flame-outs. (This decision is supported by considerable data on pilot-error accidents.) The result was a requirement that jet-engine fuel systems shall deliver all fuel to the engine without manual control by the pilot.

Fig. 4 shows one way that automatic sequencing is accomplished. Centrifugal electric pumps in the wing and auxiliary fuselage tanks transfer fuel to the main tank through an automatic level control valve, keeping the main tank full until all other tanks are exhausted. Check valves are required to prevent transfer to a tank having an inoperative pump. Feed from various tanks may be proportioned by means of restrictors if required for airplane balance.

Vapor Suppression

Fig. 5 shows the complication added in meeting the requirement that the system be designed for fuel conforming to MIL-F-5624, which includes Grade JP-3 having a Reid vapor pressure of 7 psi

Jet-Fighter Fuel System

Starts Like This . . .

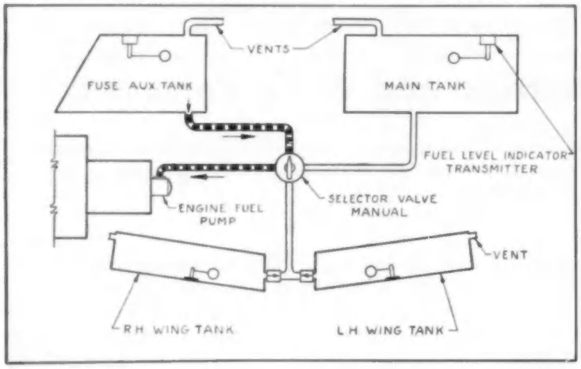


Fig. 3—Simplest system that can be used with multiple internal tanks

Gets Automatic Tank Sequencing

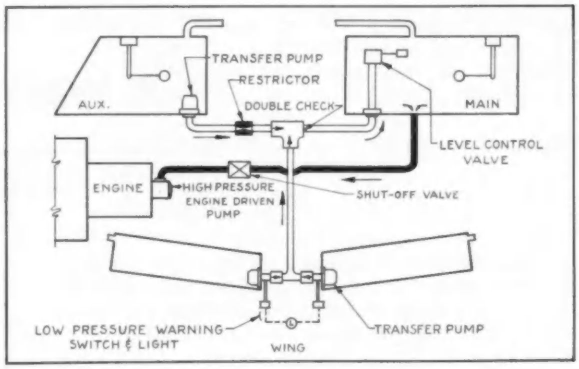


Fig. 4—After getting devices to permit automatic sequencing of fuel tanks, the system looks like this

Adds Vapor Suppression

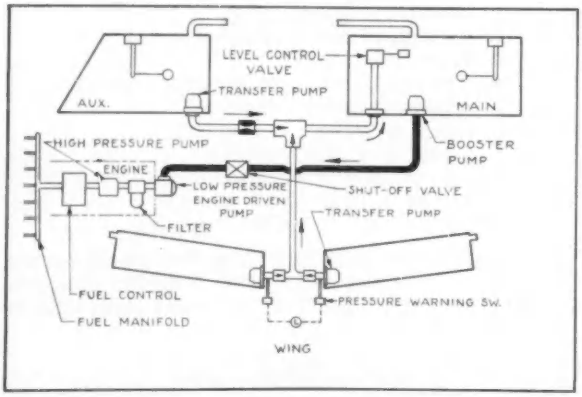


Fig. 5—Requirement for vapor suppression is met by tacking on two booster pumps

Acquires Drop Tanks

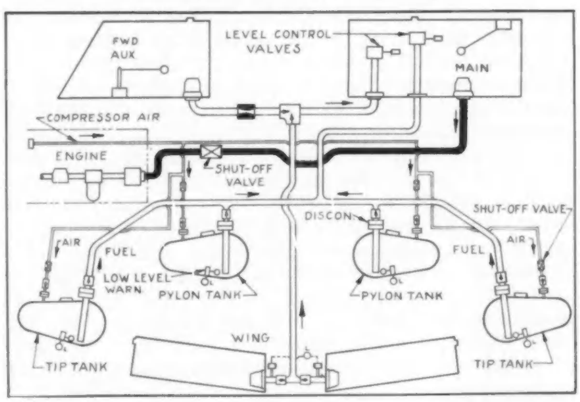


Fig. 6—Next, to give the airplane additional range, the system acquires more tanks and trappings

maximum. The system must also be operable on aviation gasoline, MIL-F-5572, having the same vapor pressure. This necessitates using a high-capacity booster pump in the main tank. It also calls for the addition of an engine-driven booster pump with sufficient capacity to give full power up to 6000 ft in the event of failure of the tank booster pump during take-off.

The reason for this additional complexity seems to be tied up with fuel availability. When JP-1 was in use, the fuel-system designer could not take advantage of its low vapor pressure because of a requirement that the system be able to handle aviation gasoline in an emergency. Moreover, availability surveys indicated that JP-1 could not be produced in sufficient quantities to fight a major war. As a result, MIL-F-5624, Grade JP-3, having a 7 psi maximum Rvp, became the standard jet-engine fuel, largely on the basis of its high availability.

When experience and research showed that JP-3 was somewhat distasteful to the engines, and that it might sustain overboard losses of as much as 70% through evaporation and entrainment, Grade JP-4 was added to MIL-F-5624. This fuel, having a Reid vapor pressure of 3 psi maximum, is currently the standard jet fuel.

There are recent encouraging indications that the U.S. Air Force will permit designing fuel systems for JP-4 only, provided a certain minimum emergency performance can be achieved on aviation gasoline. This would permit, for the first time, designing an aircraft fuel system for a fuel of less

Grows Too Much Like Topsy

Picks Up Auxiliary Fuel Systems

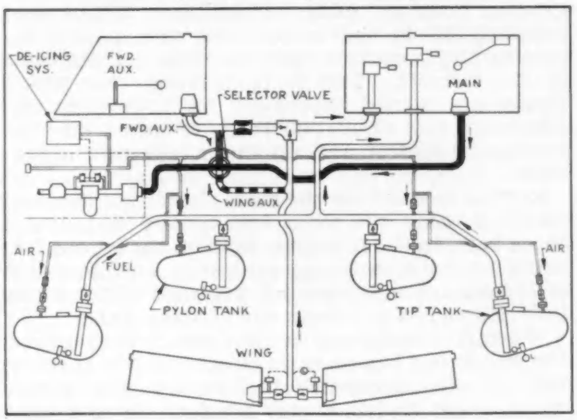


Fig. 7—More plumbing permits fuel to be fed to the engine from tanks other than the main tank

Takes on Filter De-Icing

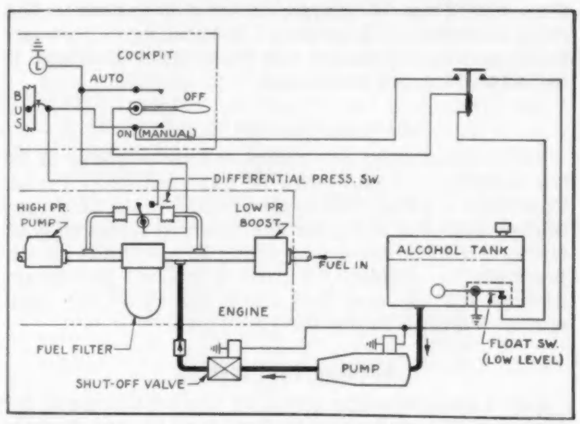


Fig. 8—Providing the fuel system with an alcohol de-icing system compounds complexity in a big way

Dons Emergency Fuel System

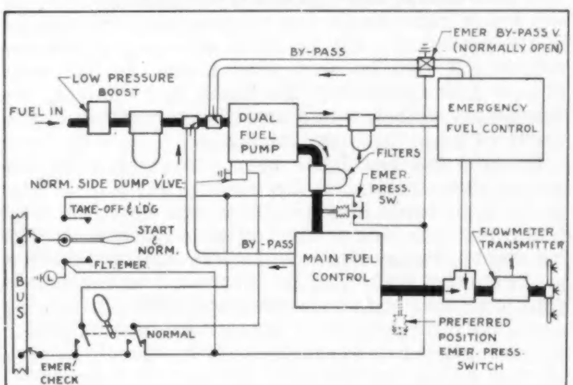


Fig. 9—An emergency fuel system chips in with unnecessary duplication

. . . Winds Up Like This!

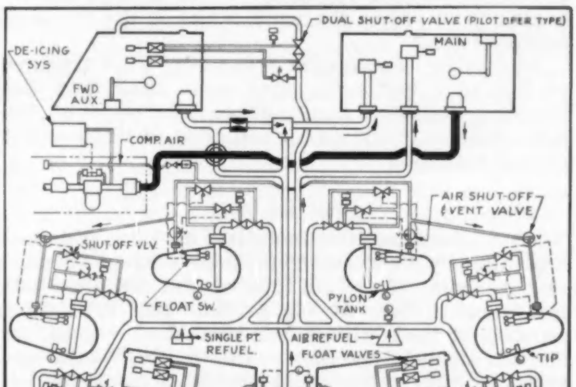


Fig. 10—By the time provision is made for air refueling, the system becomes a real jungle of parts

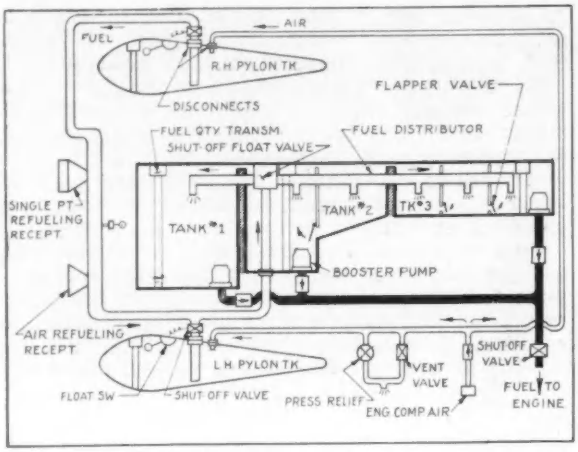


Fig. 11—This shows what can be accomplished if a concerted effort is made to reduce fuel-system complexity. The system shown above meets the same requirements as the one shown in Fig. 10

than 7 psi Rvp. Although this is a long step in the right direction, it is doubtful if boosting can be entirely eliminated unless the Reid vapor pressure is cut back to 1 psi maximum.

Extended Aircraft Range

Fig. 6 illustrates the complication introduced by the addition of two pairs of external drop tanks. This adds another float valve in the main tank, set higher than the valve for the internal tanks so that the external tanks empty first. It also adds an air pressurizing system for fuel transfer, pull-apart fittings for air and fuel lines, check valves, and empty warning lights for each tank.

Auxiliary Fuel Systems

Fig. 7 indicates the effect of the requirement for auxiliary systems whereby fuel may be fed directly to the engine from tanks other than the main tank in an emergency. By substituting a selector valve for the shutoff valve and adding the required plumbing, boosted fuel may be fed directly to the engine from either the wing tanks or the fuselage auxiliary tank.

The system shown here does not prevent transfer of fuel to a battle-damaged main tank, but this function has been incorporated into some of the later systems involving air refueling or single-point ground refueling.

Filter De-Icing

Fig. 7 also shows the fuel filter de-icing system—a mandatory requirement on most current production fighters. A better idea of the complexity it introduces is given by Fig. 8. Note that it calls for an alcohol tank with a low-level float switch, an electric alcohol injection pump, an electrically operated shutoff valve, a differential pressure switch which senses the fuel pressure upstream and downstream of the fuel filter, a cockpit control switch, a warning light, and the necessary relays and wiring.

This system is supposed (the word is chosen deliberately) to function as follows: When ice collects on the filter element, the pressure drop builds up to the setting of the pressure switch and the warning light comes on. The pilot then puts the switch in the auto position. This energizes the relay that opens the shutoff valve and starts the injection pump. When the alcohol has melted the ice, the pressure switch opens, putting out the light, stopping the pump and closing the valve. The pilot then returns the switch to the off position. The manual switch position is added in case the pilot thinks he has ice but the pressure switch isn't working. The low-level switch in the tank was added in an attempt to reduce the number of pumps that were being burned out by dry running when the filter "ice" turned out to be dirt.

Emergency Fuel System

Fig. 9 shows a typical turbojet-engine fuel system including an emergency system. Aside from control switches, most of the components are usually located on the engine. The emergency fuel system, however, adds considerable weight and complication to the overall fuel system and increases the operating and maintenance problems of the aircraft. This is particularly true where pumps are carried exclusively for emergency use, automatic flow regulation is incorporated into the emergency control, and automatic take-over is provided.

Normal flow is from the main element of the dual pump, through the main fuel control and double check valve to the fuel spray nozzles, the bypass fuel being returned to the pump inlet. The discharge of the emergency element is returned to the pump inlet through a normally open bypass valve.

When the emergency control circuit is energized, the emergency bypass valve closes and flow is set up through the emergency fuel control and double check valve to the engine nozzles. At the same time, the normal system dump valve opens, bypassing the discharge of the main pump element directly to its own inlet.

The system shown in Fig. 9 has a deficiency which has been under discussion for some time. Note in the lower right-hand corner, the phantom outline of the preferred position of the emergency pressure switch. It can be seen that if the switch were placed downstream of the main fuel control, the emergency system would also give protection in the event of main fuel control failure.

Certain engines have been equipped with the switch downstream of the control but a shuttling problem dictated moving the switch up to the fuel pump pressure side of the control. Apparently, the inherent pressure-drop characteristics through the main control could not be controlled to the extent that it would not fool the pressure switch into being actuated during landing operations (during which the throttle is retarded close to or in the idle range). Various types of differential pressure switches failed to correct the trouble.

The result is that the emergency system shown in Fig. 9 actually gives automatic protection only in case of engine pump failure. It will not take over

automatically if fuel pressure fails completely due to malfunction of the engine control. To make matters worse, the setting of the pressure switch is so low that automatic take-over will occur only if the failure of the fuel pump is complete. In short, there is no protection whatsoever, in either take-off or landing, against an engine control malfunction which might reduce the engine speed by any amount down to idle speed.

This lack of partial failure protection is very undesirable, but experience shows that it has not been very troublesome in practice. And attempts to correct this lack of partial failure protection in the design of other types of emergency control systems have led to even worse hazards.

In addition to their many deficiencies, emergency systems sometimes have a detrimental effect upon the reliability of the normal systems.

Inverted Flight

To comply with the requirement for one minute of inverted flight, it is necessary to use a double-ended boost pump or a sump arrangement which will feed the required fuel to the engine during negative G operation.

Naturally, this complicates the normal fuel system and adds considerable weight to the airplane.

Air Refueling

Fig. 10 depicts a completely automatic fuel system including provisions for air refueling. Note the complications added by the requirements for dual shutoff valves and associated pilot lines necessary to prevent over-filling and subsequent destruction of the tanks during air refueling operations. (Not only are the electrical and test systems omitted from this drawing, but so are the probe-locking hydraulic mechanism and other special structural provisions.)

A complete description of the functioning of this system is far beyond the scope of this article. Briefly, however, it consists of a long list of parts such as float switches, dual shutoff valves, solenoid shutoff valves, air shutoff and vent valves, and an air-refueling receptacle including its associated doors, hydraulic cylinders, probe-locking mechanisms, and other parts.

Single-Point Refueling

The latest revision in the Handbook of Instructions for Aircraft Designers requires that all fighter aircraft be equipped with a pressure refueling system. The inlet provisions for supplying this system may be either a ground-refueling adapter, an air-refueling receptacle, or both.

If the mission of the airplane requires that an air-refueling system be specified, the overall complication of the system is increased very little by adding ground-refueling provisions. The only added parts are the standard ground-refueling adapter and the tubing connecting it to the manifold.

On the other hand, when the mission of the aircraft does not require air refueling, the requirement for single-point ground refueling introduces almost as much weight and complication as would be required for air refueling.

What Requirements Are Warranted

Now let's take a run down on the merits of each of these factors which contribute to jet-fighter fuel-system complexity.

1. **Multiple Internal Tanks:** Use of multiple internal tanks is usually unavoidable. In any case, at least two are required by current specifications. Although this requirement has been waived in the case of some fighter aircraft, it appears to be justified provided the airplane can sustain battle damage to either tank without being destroyed by fire.
2. **Automatic Sequencing:** This requirement is considered justified. Its complicating effect can sometimes be partially offset by fuel-system design.
3. **Vapor Suppression:** Fuel-system complexity has been aggravated by designing for fuel of 7 psi Reid vapor pressure, either as a main or alternate fuel. Some airplane model specifications now permit designing the fuel system for JP-4 only. It is recommended that this principle be made general by a revision of the HIAD, and that the emergency performance required on 7 psi Rvp fuels be clearly specified. It is further recommended that studies be made to develop a standard fuel of satisfactory availability with a maximum Reid vapor pressure of 1 psi or less.
4. **Extended Range:** The requirement for external tanks appears warranted by tactical considerations. This complicating effect may be offset to some extent by (1) using fewer, larger tanks, (2) using ground-removable instead of jettisonable tanks where feasible, and (3) merging the transfer system with the air-refueling system as much as possible (where air refueling is specified). Some thought should be given to the possibility of eliminating external tanks by more frequent air refueling.
5. **Auxiliary Fuel Systems:** Considering the additional protection achieved by this relatively small increase in complexity, this requirement appears to be justified.
6. **Filter De-Icing:** This requirement is considered entirely unjustified. It is recommended that the requirement for alcohol de-icing be abandoned and tests run to determine if any form of filter de-icing is necessary. If necessary, the requirement for locating the micronic filter on the engine should be enforced, and thermal protection should be specified.
7. **Emergency Fuel System:** Considering all the drawbacks of emergency fuel systems, it is questionable whether they pay their freight.

   The authors in 1951 examined all records of F84 operation (both domestic and combat) and found only two cases of partial failure in 300,000 hr of flying. Therefore, the reliability of the normal fuel system appears good enough to warrant elimination of the emergency system. The money and ingenuity now going into emergency systems would be better spent in perfecting the normal system so as to achieve first order reliability.

   In short, this requirement should be deleted

as a general requirement for single-engine airplanes. It should be reserved for new and untried engine fuel systems and for special applications.

8. **One Minute Inverted Flight**: This requirement is considered excessive. It is doubtful if there is an actual military need for one minute of inverted-flight operation. The situation would be alleviated if a more realistic time limit were specified, and adjusted as necessary for the type and duties of the airplane. Based on experience with existing satisfactory fighters, a requirement of 5 sec at full power at sea level appears to be reasonable. (The endurance would be longer at altitude due to reduced fuel flow.)
9. **Air Refueling**: Although this requirement introduces more fuel-system complexity than any other single item, it appears to be justified for a certain segment of our fighter force. There seems to be no other method of providing high mobility and extremely long-range operation. The complicating effect can be reduced somewhat by careful system design.
10. **Single-Point Refueling**: When it is considered that most fighter aircraft can be refueled in a reasonable time through open filler caps by using several delivery trucks, it is questionable that the weight and complexity of a pressure refueling system is justified. An industry survey is now being conducted by SAE Committee A-16 to determine the position of the aircraft industry on this requirement. The results should prove very interesting.

    In the event it is found necessary to retain this requirement, steps should be taken to reduce the weight penalty by eliminating as many tank filler caps as possible.

A Sample of What Can Be Done

Now let's consider what can be done to reduce fuel-system complexity without sacrificing safety, utility or airplane performance.

Fig. 10 shows a fuel system designed to meet the same requirements as the system shown in Fig. 2. A marked reduction in complexity is clearly obvious.

In the first place, even though this system provides the same range without refueling, the need for wing tanks has been eliminated. (For the plane configuration chosen, more fuel could be carried in the fuselage.) Two large external tanks are used instead of four small ones.

Moreover, the three fuselage tanks are located adjacent to each other so that they can be interconnected at the top. Thus it is possible to make them function as a single tank insofar as venting and air refueling are concerned.

The use of one dual valve for refueling the three internal tanks, and a single rather than dual valves for the external tanks, greatly reduces the number of components required in the air-refueling system.

For that matter, studies are in progress on a simplified valve for this location. At present a dual valve is required because the failure of a single valve might cause tanker pressure to rupture the tanks.

Even if further simplification of this fuel-level control valve is not possible, the system shown represents a substantial simplification in the air-refueling provisions. It also handles the transfer of fuel from external to internal tanks.

It will be noted that fuel is delivered to the engine through three booster pumps operating in parallel through three check valves. Fuel is fed to the engine proportionally until one tank is empty. Then the remaining pumps shut the check valve on the dry pump and continue until all three tanks are empty. This takes care of feeding all fuel without attention from the pilot. It also provides the equivalent of two auxiliary systems without the necessity of operating a selector valve. In the event of boost pump failure or battle damage to any two tanks, the third continues to supply the engine with boosted fuel. With this arrangement, the engine-driven booster pump can be eliminated.

No provision is made in this system for one minute inverted flight. The large manifold required by this design is expected to result in somewhat better negative G tolerance than is available and considered acceptable in current production fighters.

Although not shown in the diagram, a micronic filter is located on the engine. This filter is provided with thermal anti-icing. An engine emergency fuel system probably would have to be used.

This simplified fuel system is merely an example of what may be possible in the way of reducing complexity.

Each new airplane design, of course, brings up new fuel-system problems. And each new fuel system must be hand-tailored for the particular airplane. But if fuel-system requirements are taken into account in the initial design of the airplane, it will sometimes be possible to use a configuration conducive to minimum fuel-system complication.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Secretary's Report of Comments by

T. R. Farrington, Wright Air Development Center

IN discussing the Service's requirements which tend to complicate aircraft fuel systems, Mr. Farrington reminded the group that a recent revision to HIAD has considerably modified a number of previous requirements. Design performance is restricted to the use of JP-4 fuel, elimination of manual filler caps is now permitted, and various other more moderate requirements have been instituted.

Mr. Farrington also stated that in his opinion fuel filter de-icing is not worth its weight. Tests have shown, he said, that if the refueling facilities are controlled, very little water is present in the fuel for ice formation. It is his opinion that lack of proper ground maintenance is responsible for most of the icing which is encountered. He recommended that adequate engine-mounted filters be developed which will permit thermal or mechanical anti-icing of the filter element. Several such devices are currently under tests, he pointed out.

What They're Saying About . . .

Passenger-Car Seating

V. A. Buck, Chrysler Corp.

Based on secretary's report of Round Table on Automotive Seating—Testing and Evaluation by Instrumentation held under the auspices of the SAE Body Activity at the SAE Summer Meeting, Atlantic City, June 9, 1953. J. C. Gordon, of Gordon-Chapman Co., moderated this round table.

FOUR engineers engaged in testing and evaluating automotive seats let their hair down at a Summer Meeting round table. They were Arthur Bassette, Fisher Body Division, GMC; R. N. Janeway, Chrysler; W. E. Lay, University of Michigan; and E. C. Pickard of Ford. Here are a few of the things they had to say:

● The **perfect seat cushion is probably a myth** that has been chased across half a century by many very competent people.

● We are **evaluating seat cushions two ways:** (1) by measuring the difference in acceleration between the car body and the passenger, and (2) by comparing the effect of acceleration on a passenger seated on a cushion . . . and on a hard wooden seat.

● **Damping is essential to restrain resonant amplification of passenger motion!** Sometime we are going to have to find a happy medium both in the degree of damping and the type of damping.

● **Money would not be taken out of a seat cushion** if it were fully realized what is happening to the passenger who rides on it.

● In testing seat cushions, we have to be careful that **what we are hearing isn't something we are feeling** and vice versa.

● We must remember that it is **possible to become fatigued in a very comfortable living-room chair.**

● Our suspension people designed a gadget for dropping a car. They couldn't find a use for it, but we did!

● **Don't get discouraged if things go wrong with seat tests.** They usually do. The instruments are right; we just don't know how to interpret them.

● We don't want the frequency of a passenger on a cushion to be equal or even close to the natural frequency of the car body on its suspension.

● The situation we have in present-day cushions is **not exactly no damping, but it's too close to this for comfort.** Unfortunately, the trend has been in the direction of less damping.

● Stated quite simply our problem is this: To get minimum amplification of passenger motion as compared with vehicle body motion at low frequency . . . and to give the passenger effective isolation from high frequencies.

● One of the most useful devices for studying the dynamic action of cushions (and passengers) is the **high-speed camera.**

● **Strain gages are especially useful as pickups.** This is because they can be evaluated and calibrated under static conditions and used to record under dynamic conditions.

● One of the biggest problems in seat-cushion instrumentation is **where to put the pickup and what kind of load to put on it.**

● Certain types of instrumentation can be used to evaluate a particular point or a multiplicity of points on a seat cushion under laboratory or road conditions.

● I wouldn't mind **taking half the chrome off a car and putting that value into the seat cushions.**

● Oscar, a plastic dummy used for seat-development work, is a **real helper in static test work.** He will deflect a seat exactly the same amount as his human counterpart.

240 MOLDS ARE SPIT OUT EVERY HOUR

by one machine (shown at right) in a just-baptized mechanized shell-molding foundry.

This is one of the all-important . . .

Tricks That Make Shell Molding

SHELL MOLDING has a lot to offer design engineers. With it, designers can get closer tolerances, finer finishes, and, in many cases, lower-cost end products—if they avoid the pitfalls!

Chief thing for designers to remember about tolerances is not to shoot for the moon. Cardinal rule here is to stick to tolerances that are feasible for a particular foundry. As a good yardstick for designers, today's shell-molding foundries are holding these tolerances: 0.003 to 0.005 in. per inch parallel to the parting line and 0.006 to 0.008 in. across the parting line. It has been found that control of tolerances is easier on smaller castings.

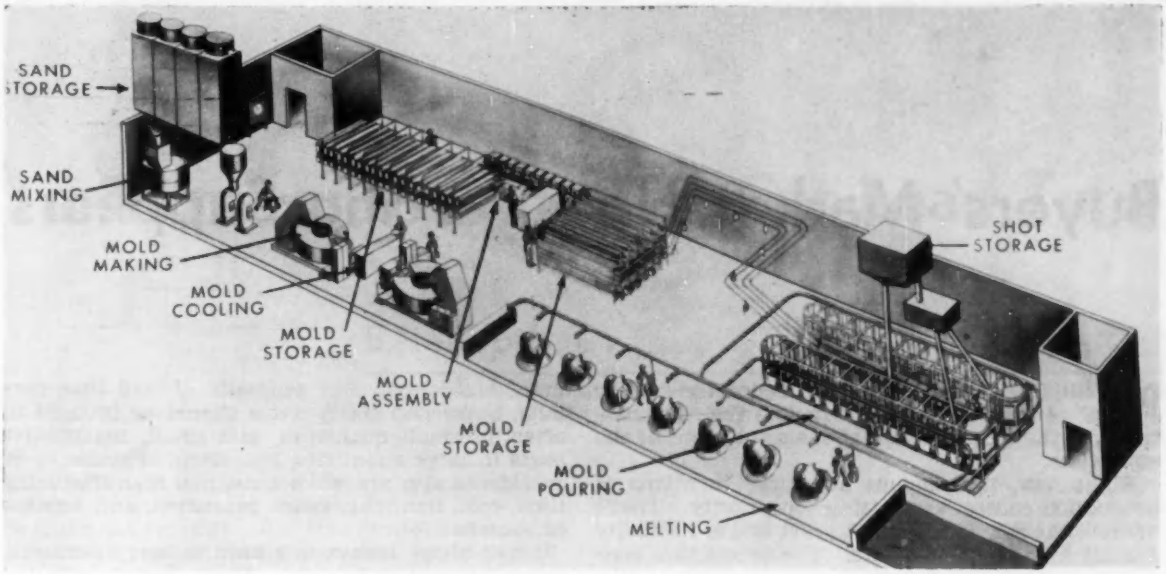
When it comes to actual design, it's important that parting over critical dimensions be avoided. Designs should be simple and laid out so that as much of the casting as possible can be made in the cope and drag. The less core work the better, since cores reduce the limits of dimensional accuracy.

Foundry costs, it is true, are usually higher with shell molding. But reduced or eliminated machining and finishing costs invariably more than make up for this. Shell molding, for that matter, won't pay off (especially on short runs) unless machining costs are drastically reduced. That's because the necessary patterns or thermo-dies cost two to three times as much as normal or green-sand patterns.

One pitfall wise designers will avoid is that of specifying too fine a finish. For the finer the finish, the higher the cost of the casting. Reason for this is that the necessary finer sands require larger amounts of resin to coat the increased surface area. And while the resin in a shell mold comprises only about 6% of the total weight, it represents approximately 80% of the total cost of the sand-resin mix. A sand with a 100 AFS fineness has been found to give good balance between cost and finish.

As for the all-important question of what should and shouldn't be shell molded, a pretty good rule of thumb is: If the weight of the metal in the casting is twice that of the sand and resin used to make the mold, then shell molding is competitive with green-sand molding.

However, mechanization of the shell-molding process is helping to make it more competitive with green-sand molding. (See above picture and caption.)



Click

W. H. L. Bryce, International Harvester Co. of Canada Ltd.

Based on secretary's report of Panel on Foundry Operations held as part of the SAE Toronto Production Forum, Oct. 29, 1953.

Having made the decision to use shell molding, the next thing to do is to bear in mind the following things:

With the shell-molding process, the die must be heated to 450 to 500 F. Gas heating is preferred, since electricity does not give uniform face temperature on the pattern.

Gating must be correct the first time. This is because thermo-dies cannot be soldered or altered in the conventional manner.

Die surfaces must be very smooth and accurate.

Shells must be ejected evenly and in one plane otherwise they will become warped while hot.

Shell molding seems to offer better strength and lower hardness in castings with sections up to 3/16 in. Above this figure, these plus qualities disappear to the vanishing point.

Actually, when it comes right down to it, the biggest advantage brought about by shell molding is in other fields of foundry endeavor. It has stimulated progressive foundrymen to do a better job in their shops regardless of the process involved.

This information on shell molding was contributed by: A. Reyburn, Foundry Superintendent, Cockshutt Farm Equipment Co.; W. Bryce, General Foreman, Grey Iron Foundry, International Harvester Co. of Canada Ltd.; F. W. A. Baulch, Works Manager, Etobicoke Works, Aluminum Co. of Canada Ltd.; A. Barczak, Works Manager, Superior Foundry Inc.; J. Perkins, General Superintendent of Production, Foundry and Heat Treat Plant, Ford Motor Co. of Canada Ltd.; A. Pirrie, Manager, Dufferin Works, Standard Sanitary and Dominion Radiator; G. P. Phillips, General Supervisor, Foundry Research, International Harvester Co.

(The report on which this article is based is available in full in multilithographed form, together with reports of the seven other panel sessions of the 1953 SAE Toronto Production Forum. This publication, SP-305, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

Buyers' Market Now Forcing Suppliers

PRODUCTION control has been called the "traffic cop" of industry. Its job: having the right material, in the right amount, at the right place, at the right time.

Right now, the amount and time functions of production control are getting top priority. That's because the current buyers' market makes flexibility a must in producing plants. The production control department is carrying a major part of this responsibility . . . with inventories and lead time its chief concerns.

Flexibility can be increased in many ways . . . banks; greater variety of raw materials; controlled floats of semi-fabricated parts; and inventories of finished parts which have a continuing demand.

But the ideal can't be attained unless raw materials are quickly available from their source. Up until recently, steel was the big bottleneck. But today the situation is being cleared up.

For the last 10 to 12 years, steel companies have been producing at greater than the theoretical maximum. They have been under constant pressure for more and more of their products, and have been unable to maintain or create inventories of semifinished materials in any form, including ingots, billets, slabs, sheets, and bars. They also have not been able to carry out regular maintenance operations within their plants. During this period, each order received has had to be scheduled right through from the ore and coal piles.

At present, because of some softening in demand, increased capacity, and improved techniques, steel companies are getting to the point where semifinished banks are again in existence. This has increased flexibility and decreased required lead time.

Greater availability of steel will result in smaller inventories in consumers' plants. There is no point in over-buying and hoarding materials that can be secured readily when needed. The insurance-policy type of inventory is on the way out. The result will be more efficient operation at less cost.

The size of banks in individual plants will return once again to the control of the treasury department, rather than the production department.

This trend accentuates the problem of just how much inventory is needed to insure adequate protection all around. The ideal would seem to be to aim at a complete turnover in one to two months.

The automotive industry has found that 20% of its items represent 80% of total value. It's using this to control dollar inventory.

There is no universal formula for float sizes of individual items. But generally, if lead time permits, bulky and costly items should be brought in often in small quantities, and small, inexpensive parts in large quantities, less often. Factors to be considered also are setup time, and manufacturing time, cost, handling, space consumed, and number of sources.

Small shops always will have to carry relatively large raw material banks. They cannot exert the same pressure on their suppliers that larger companies can.

Since the beginning of World War II, suppliers have been so sought after by users, that they have dictated to their customers when and how much material would be supplied. This condition has tended toward long lead times, both because of necessity, and because of the theory of first come, first served.

The time has come now when suppliers will have to assume their rightful share of responsibility to their customers. Suppliers cannot expect a long lead time. They will be required to level off their operations, so that they can produce economically and retain their skilled labor. Suppliers will have to store part of their end product.

Opinion differs between supplier and consumer as to what lead time should be in effect now. Suppliers feel that they still need six months minimum and seven months maximum. Consumers feel that, under present conditions, they cannot forecast their requirements that far ahead. Agreement in each instance must be reached by mutual discussion. It should not be difficult where more or less standard items are concerned. Special items vary with each producer and time required will depend on his willingness to maintain an inventory of finished items.

Up to now consumers have deliberately ordered more parts and materials than they required on the theory that they would get what they could. Producers have been over-selling their capacities, and then trying just to get by, making shipment in small quantities to those customers who kept the most pressure on them. Neither of these practices is desirable.

Customers wish that producers would not try to out-guess their schedules or banks. If they could depend on this, the customers would schedule more realistically.

From here on, producers will have to sell delivery and service as well as product.

Production schedules, for most companies, should

To Increase Inventories, Cut Lead Time

B. I. Booth, Chrysler Corp. of Canada, Ltd.

Excerpts from secertary's report on Production Control and Materials Handling Panel of the Production Forum at the SAE International Production Meeting, Toronto, Oct. 29, 1953.

be made out monthly. But this cannot apply to job shops who must schedule according to many individual orders Suppliers must take some of the risk in running and storing regularly scheduled parts. Modern punched card systems can be used advantageously, both for scheduling, and material control operations. They are adaptable, particularly for large volume production of repetitive parts, but are not feasible for job shops. The automotive industry has not used them more extensively because the required equipment has not been available. This situation is clearing up now, and it is possible that this new medium for control will become more widely used in the future.

Materials Handling

The panel also discussed materials handling and came up with these 12 principles for efficient handling of materials:

1. Materials should be moved in the largest units possible, consistent with safety and convenience, to minimize cost.
2. The size of loads should be uniform and conform to available equipment, aisle sizes, ceiling heights, and other physical peculiarities of the plant.
3. The flow of material should be consistent with manufacturing requirements.
4. It should be recognized that sometimes, because of small volume or large initial cost of equipment, it is desirable to use less efficient methods for handling of material in a particular plant.
5. The efficiency of a material handling method is determined by considering the cost to deliver one unit of the material where needed, plus the operating cost and maintenance cost of the equipment involved.
6. Machine operating time, processing time, and all other fabricating time elements, must be considered when supplying material to an operation.
7. Generally, material should not be on the floor.
8. Constant demand items should be stored where most accessible, consistent with space limitations and safety.
9. Equipment operated by gravity is the most economical.
10. Controlled conveyor systems are sometimes desirable for large volume and continued operation.
11. Cranes are desirable for intermittent operations which can be confined to a definite area within reach of the crane.
12. Material can be handled with less effort, confusion, and cost on second and third shifts, if production is not operating.

(The report on which this article is based is available in full, together with the seven other secretaries' reports from this Production Forum, as SP-305 from SAE Special Publications Department, 29 West 39th St., New York 18, N. Y. Price: $1.50 to members, $3.00 to nonmembers.)

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Diesel "Doctors" Draw Bead on Exhaust Valve

DIESEL exhaust valves still suffer from the same maladies (breakage, guttering, sticking, and so forth) they did years ago. But one thing has changed. Today, more attention is being given to curing these ills!

First of all, surveys have been made to find out which of these ailments valves contract most often. Next, the disorders found to be most prevalent have been diagnosed to determine what brought them on. Then, keeping these facts in mind, researchers have headed for the laboratory.

So far, no one has come up with a patent medicine that will cure everything. But a number of treatments being investigated do show promise of being effective vaccines against at least some of these valve diseases.

Before discussing these potential remedies in detail, however, let's start at the beginning and see what diesel-engine makers consider to be the most bothersome valve malady.

Valve Breakage Is Worst Offender

Fig. 1 shows the result of just such a survey. As can be seen, valve breakage won this dubitable honor hands down. Over 60% of the manufacturers reported it as plaguing them most. Guttering ran a poor second with slightly over 10%.

Valve breakage, it was known, falls into two categories: (1) breakage due to impact fatigue, and (2) breakage due to thermal fatigue.

Breakage due to impact fatigue may occur at any point on the valve head or stem. Generally, however, it takes place where stress raisers act as nuclei for valve failure. (See Fig. 2.)

Thermal-fatigue failure nuclei, on the other hand, originate at the valve-head outside diameter or on the valve face and show up as one or more radial cracks. (See Fig. 3.) The stresses responsible for these cracks are circumferential and may consist of (1) thermal stresses developed by temperature differences within the valve, (2) thermal stresses due to differential expansion of the body and surface material of the valve, (3) residual stresses retained from the production of the valve, and (4) mechanical stresses induced by service conditions.

Thermal Fatigue Causes the Disease

A survey of diesel-engine manufacturers showed thermal fatigue to be the most frequent cause of valve breakage. (See Fig. 4.)

To researchers, this indicated a need for a valve material that would first and foremost be highly resistant to thermal fatigue. (The material would, of course, also have to be able to resist impact fatigue and possess good resistance to oxidation at elevated temperatures.)

However, while laboratory tests for evaluating oxidation resistance and impact strength are common, not much has been done to date to evaluate thermal fatigue of a material.

To obtain comparative data on this characteristic in an engine would require, we knew, a very long and expensive test program. Therefore, it was necessary to try to duplicate this type of failure in a laboratory bench-test apparatus.

The test rig developed for doing this is shown in Fig. 5. Valves are alternately heated by an induction coil and cooled by a watercooled seat. By producing drastic temperature differentials in this way, the thermal fatigue of a material can be determined in a matter of minutes.

Some Materials Fight Off Thermal Fatigue Better

To date, a considerable amount of thermal-fatigue data has been obtained on materials commonly used for diesel exhaust valves. Fig. 6 shows the relative cracking tendencies of these materials. (The larger the number, the greater the resistance to cracking.)

The laboratory data thus far obtained have been substantiated in service. It was found, however,

Maladies

J. A. Newton, Valve Division, Thompson Products, Inc.
J. L. Palmer, Lubrizol Corp.
V. C. Reddy, Detroit Diesel Engine Division, GMC

Based on paper "Factors Affecting Diesel Exhaust Valve Life" presented at SAE National Diesel-Engine Meeting, Chicago, Nov. 4, 1953.

that small differences in relative cracking tendency had little significance in service. But when the spread was two or more points, there was an appreciable increase in service life.

Other information learned about thermal fatigue can be summed up as follows: (1) facing thickness on a valve affects its resistance to thermal fatigue, (see Fig. 7); (2) the method of applying the facing material alters its structure which, in turn, affects its resistance to thermal fatigue; and (3) the structural characteristics of the different facing materials significantly affect the thermal fatigue of the valves on which they are used.

The test rig also proved to be a good test tube in which to evaluate other potential valve-life extenders—shot peening, cold working, heat and quench-

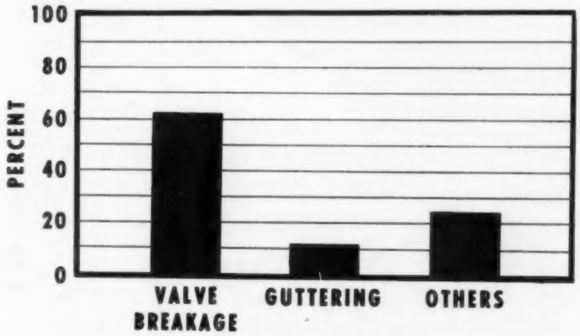


Fig. 1—Worst diesel exhaust-valve trouble being encountered today is valve breakage

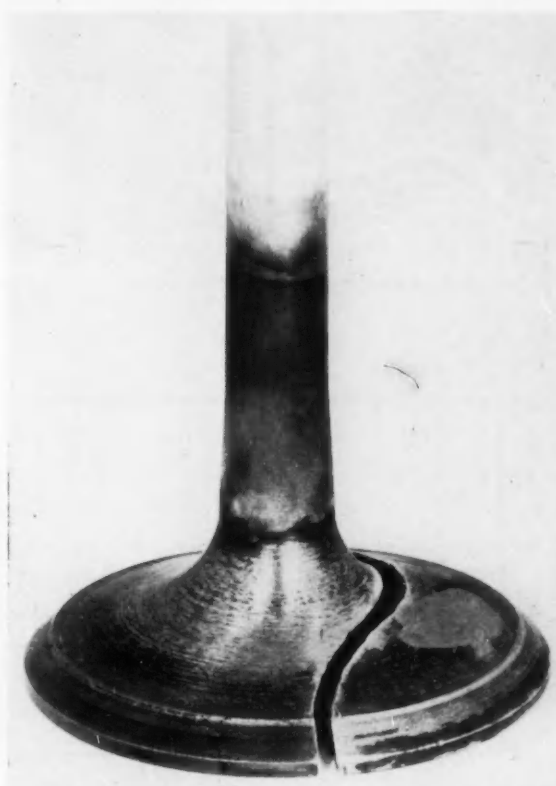


Fig. 2—Valve breakage due to impact fatigue usually takes place where stress raisers act as nuclei for the valve failure

ing. The surface residual compressive stresses produced by these methods were found to give beneficial results in laboratory tests. However, to what extent these improvements will be realized in service has not been established as yet.

Before leaving the subject of valve breakage, it should be pointed out that this program is still in its infancy. Much valuable data have already been obtained that will undoubtedly be of help in the quest for a new and improved material with greater resistance to valve breakage.

Guttering Takes It Out of Valves Too

Now let's study the case history of the next worst disease suffered by valves—guttering.

Except where inferior valve material is used or completely inadequate valve cooling exists, valve guttering or burning is always caused by failure of the valve to seat properly. This allows hot gases to blowby the valve at very high velocity, causing burning of the valve face and seat. Often this burning occurs in the form of a gutter. (See Fig. 8.)

The use of materials that are very resistant to high-temperature oxidation helps avoid burning. However, when severe guttering occurs it is usually necessary to eliminate one or more of the following conditions to effect a cure:

1. Cracks or flaws in the valve or seat.
2. Warping or distortion of the valve head, valve seat, and/or cylinder head.
3. Peening or "brinelling" of the face or seat by metal chips or hard particles of combustion-chamber deposit.
4. Insufficient valve lash.
5. Sticking of the valve stem in the valve guide.
6. Formation of a brittle deposit on the valve face or seat, which subsequently chips off and forms a channel for the escape of the hot gases.

Ways to Ward Off Guttering

Many times guttering is brought about by improper selection of valve materials. In such cases, the material does not possess adequate oxidation resistance. With the slightest amount of leakage at the seating surface, guttering progresses over a wide area. The obvious remedy for this type of guttering is a better material.

Perhaps the most difficult type of guttering to

Fig. 3—Valve breakage due to thermal fatigue is initiated by one or more radial cracks

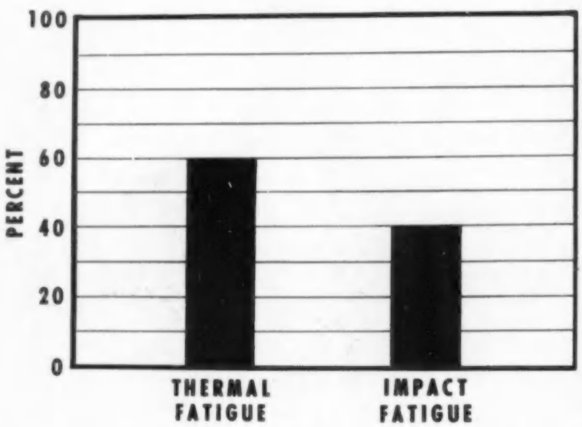


Fig. 4—Thermal fatigue is the most frequent cause of valve breakage

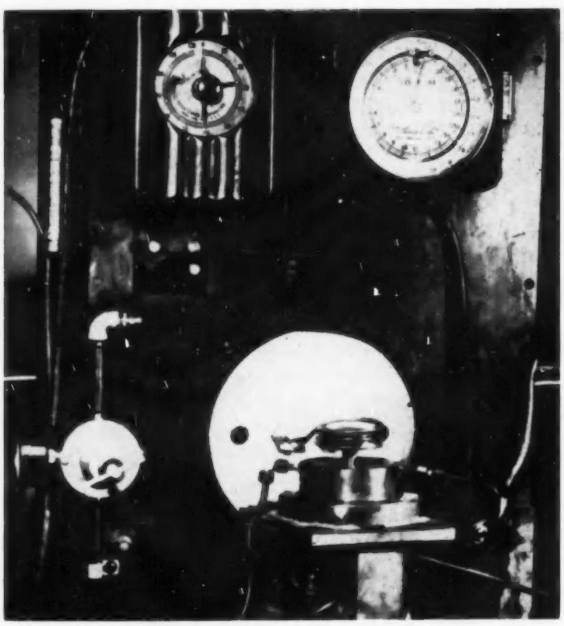


Fig. 5—Test rig developed for evaluating thermal fatigue of valve materials

XCR	1
SIL 10	3.5
21-4NS	5
SIL 10N	5.2
2112N	5.5
XB	6
71360	6.6
SIL 10 TREATED	8.6
XB STELLITE 6 FACED	10.8

Fig. 6—Relative cracking tendencies of valve materials (the larger the number, the greater the resistance to cracking)

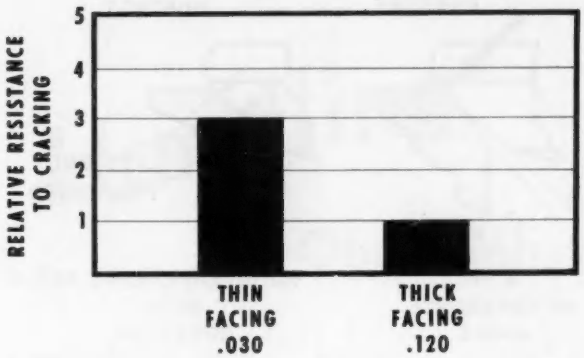


Fig. 7—This shows the effect of valve facing thickness on resistance to radial cracking

cure is that due to cylinder-head distortion, which causes the valve seating surface to warp out of shape. There is no easy solution to this problem.

Some compensation for cylinder-head distortion can be made by reducing the rigidity of the valve head and allowing it to conform to the distorted valve seat. Beyond certain limitations, however, the valve-head sections would be weakened to the point where valve breakage occurs. It is a cut and try proposition to determine how much cylinder-head distortion can be tolerated in any individual engine, and to what extent the valve head can be lightened without provoking breakage.

Guttering may also be brought on by sticking of the valve stem in the valve guide. This sticking may be caused either by stem and guide scuffing or by deposits at the hot end of the stem and guide.

Until quite recently it has been considered necessary to lubricate the exhaust-valve stem to prevent scuffing and subsequent sticking. But it has been recognized that an oversupply of lubricant could provoke sticking because of the formation of a carbon deposit at the hot end. Additive oils, carbon scrapers, deflector valve-stem designs, counterbored valve guides, and valve rotators have been used to permit adequate lubrication while minimizing this type of deposit and its effects. (See Fig. 9.)

One possible new remedy for this valve-stem sticking and, to some degree, the valve-head deposit problem would be to remove the oil from the valve stem. In other words, block the oil from the valve guide and allow the valve stem to run dry. A valve-guide material capable of fulfilling this condition has been produced and is available to engine manufacturers at the present time on an experimental basis.

Still other epidemics of guttering are initiated by deposits. Frequently chunks of deposit from the combustion chamber or valve head become dislodged and brinell the seating surfaces causing the

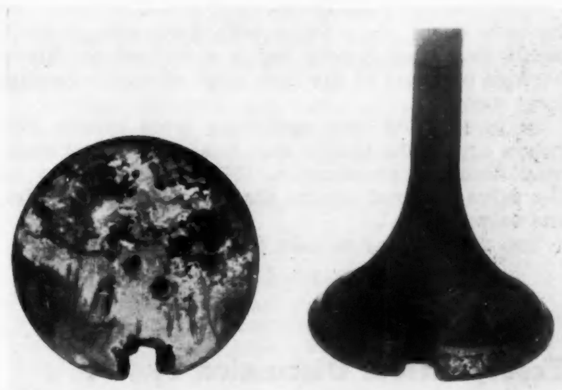


Fig. 8—Valve burning often occurs in the form of a gutter

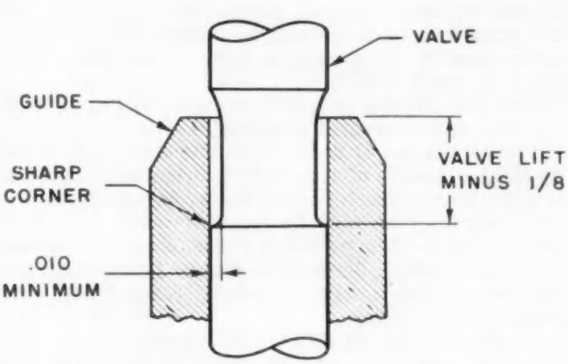


Fig. 9—Use of a carbon scraper is one way to combat valve guttering

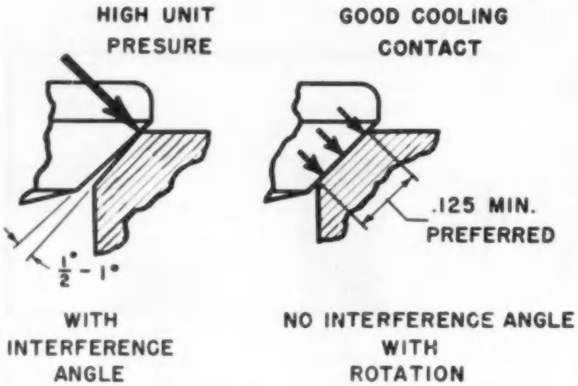


Fig. 10—An interference angle between the valve face and seat helps crush deposits and prevent subsequent guttering

valve to burn. Or a valve with little total deposit on its face may rapidly reach a burned condition because portions of the thin layer of brittle deposit flake away.

Depending on the materials from which the valves are made, valves may heal or the guttering may become catastrophic. When indentation of the valve material occurs, there is no possibility for the valve to heal.

The obvious way to take care of this type of guttering is to prescribe a hard valve material or facing material.

When valve-face deposits are sufficiently troublesome, use of an interference angle between the valve face and the valve seat is a good idea. (See Fig. 10.) That's because an interference angle will help crush the deposits and prevent subsequent guttering.

An interference angle, however, is definitely not advisable with rotated valves which require full use of the maximum seat width to facilitate good valve-face cooling and to prevent valve-face grooving and seat wear.

The effect of rotation on valve-face deposits is somewhat clouded. Some users of valve rotators report improved face conditions; others claim no improvement at all.

Diesel manufacturers that do specify valve rotators, however, are unanimous in reporting that they (1) minimize the effects of valve-seat distortion, (2) prevent sticking, (3) prevent stem wear, (4) lessen guide wear, and (5) improve tip condition.

Actually, due to the many factors affecting the performance of an exhaust valve, it is impossible to prescribe a universal valve design or material. Valves which fail prematurely in one engine may be most satisfactory in another. In fact, it might be necessary to use several different designs of valves made of two different materials in the same engine series to obtain the best performance for a particular application. For this reason, only through experience and test can optimum valve design and material be determined.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Excerpts from Discussion by . . .

P. J. Sperry
International Harvester Co.

As a manufacturer of diesel engines, it has been our misfortune to encounter nearly every type of trouble described in this paper. We have also had the good fortune to be able to correct most of these difficulties by using one or more of the plans outlined by the authors.

Thermal fatigue encountered with valves of XCR material was corrected by using 21-4NS.

The formation of deposits on the valve stems and head as a result of excessive lubrication has been a particularly tough nut to crack, especially in engines working at light loads. The authors suggest avoiding extended periods of idle or light-load operation. I wish I knew a means of persuading the gentlemen who operate shovels, track lines, and graders to do this.

Since it would be difficult to completely re-educate the operators of this type of equipment, it seems advisable to pursue with vigor the development of valve trains which will accept this type of operation without trouble. In our efforts along this line, we reduced the flow of lubricant to the point where we were in danger of scuffing valve stems—and still encountered trouble with deposits.

We then discovered that a change from broach-type finishes to reamed finishes in the valve-stem guide would permit operation with less lubrication.

We attempted to use interference angles. But it was found that before a good seat was developed, the valve face would become coated with a rather brittle deposit which prevented further development of the seat. As a result, we have eliminated the interference angle and are now lapping valves in place.

We also tried using valve rotators—again without too much success. It was found necessary to combine the rotator with hard-faced valves and valve seats. Even then exhaust valve life was not improved appreciably over the production setup.

Question: What is the material in the bushing that doesn't require oil?

Answer: It is a trade secret. All that can be said is that it is a powdered material impregnated with dry lubricant. The porosity can be varied to gain the best dry lubricity.

Factors in Engineering Your Materials Handling Operations

F. C. Bassick, Douglas Aircraft Co., Inc.

Based on secretary's report on Panel on Materials Handling of the Aeronautic Production Forum at the SAE National Aeronautic Meeting, Los Angeles, Sept. 29, 1953.

MATERIALS handling has become the tail that wags the dog in many plants today. In most small plants it used to be only an afterthought, with machine layout getting the main emphasis. Today materials handling is a pretty complex science that often can spell the difference between profit and loss in a company. It has to be engineered from product design right through handling equipment selection to operation.

In the aircraft business particularly, the trend toward heavier and larger parts has pointed up the materials handling problem.

For example, the wing skin of a late fighter model is milled on a large skin milling machine. It starts out as a 2-in. aluminum slab 4 ft wide by 20 ft long. Handling problems arise in storing the raw stock, loading the machines, and moving the sections through their many operations. To top it off, huge quantities of chips removed in machining have to be gotten out of the way quickly because of the need for scratch-free surfaces.

In one particular case, materials handling set the pattern for the plant layout. New techniques for handling these skins had to be worked out. Analysis of the final fix showed sizable dollar savings.

Situations such as this one show it's smart business to recognize materials handling problems as early as possible in material flow planning. One company has materials handling preplanners in the engineering section who advise while the design is still on the drawing board.

Production build-up usually involves several production-rate phases. Since each production rate affects the kind of equipment needed and money available, materials handling planning should be broken down into these same phases.

Inside and Outside Transportation

Pretty early in the planning, factory men should accept the fact that internal and external movement are integral parts of the same service package. Most effective handling comes from visualizing materials handling as *complete* movement of parts and materials from point of procurement to end product.

However, internal and external transportation are different kinds of problems.

Purchasing commercial transportation on public

Meet the Panel

Materials handling no longer is a babe in swaddling clothes. It has grown to a position of significant proportions in most plants today. And it affects practically every phase of manufacturing operations.

That's pretty well confirmed by the diversity of responsibilities found among the panel of specialists which led the discussion from which this article is drawn. They are:

- **A. C. Wallen,** Panel Leader
  Tooling Manager,
  Douglas Aircraft Co., Inc.,
  Long Beach Division
- **J. E. Van Dorn,** Panel Co-Leader
  Superintendent—Warehousing,
  Northrop Aircraft Co.
- **F. C. Bassick,** Panel Secretary
  Facilities Engineer,
  Douglas Aircraft Co., Inc.,
  Long Beach Division
- **R. L. Clark,**
  Methods Engineering Manager,
  Ryan Aeronautical Co.
- **Fred Wythe,**
  Supervisor, Industrial Engineering,
  North American Aviation, Inc.
- **R. F. Hurt,**
  Chief Project Planner,
  Lockheed Aircraft Corp.

Fork Lift or Trackless Train?

In floor handling equipment, the choice sometimes has to be made between a fork lift truck or trackless train.

An Air Force depot analysis throws some light on this determination by showing that:

- **For loads moved up to 300 ft, use a fork lift truck.**
- **For loads moved 300 to 1000 ft, use both, with the fork lift truck as a tug.**
- **For loads moved over 1000 ft, use a fork lift truck at each end with a trackless train in between.**

highways calls for compliance with federal, state, county, and city regulations. Company rules hold for intraplant operations.

In the plant it's much easier to maintain supervisory control. For example, several companies control operations with two-way radios on tugs and fork lifts, and improved efficiency 100%. Two-way radio in overhead cranes reduced delays considerably for another company.

Personnel too can be controlled better within the plant. In one factory, a materials handling committee worked up for each supervisor a check list showing the following items:

1. Can some materials handling or movement be eliminated?
2. Are materials loaded and unloaded PROPERLY?
3. Are materials loaded and unloaded PROMPTLY?
4. Are materials properly protected and packaged for storage and transport?
5. Are materials stored properly and efficiently?
6. Are materials transported in the proper equipment?
7. Does incoming material go directly to work areas wherever possible?
8. Are rejected parts protected from further damage?

Another company combines its materials handling problems with its safety and housekeeping committees. Still a third plant furnishes a manual to supervision showing standard and special equipment, right and wrong ways of loading.

Handling Equipment Selection

Moving material from one work station to another takes the biggest single bite out of the manufacturing dollar. That's why this area holds a large potential for cost reduction. And the biggest single gain here can be made through mechanized materials handling.

Applying mechanized methods demands complete analysis and planning of the operation. It entails considerations such as:

1. Is the material durable or fragile, bulk or package? What is the package size? Is it palletized?
2. What is the volume of materials to be moved? Is the movement constant or intermittent?
3. Is the system to be planned and built into a new building, or will it be superimposed into existing facilities?
4. Must it move in a fixed path?

Most materials handling systems offer wide flexibility. But none can be applied universally. Nor is there a pat answer for the write-off period for amortizing mechanized equipment. It varies as to: (a) amount of capital money to be spent; (b) amount of money directly affected by government contracts; (c) floor space that can be saved; and (d) intangible factors such as requirements to maintain schedules.

Another easy way to save money in materials handling is to buy standardized equipment. It costs less in the first place and is cheaper to maintain.

Most suppliers will extend discounts on large quantity purchase of shelf or catalog items. Even with specially designed equipment, fabricators can build 10 units at a lower price than they can build one.

Maintenance costs go down for several reasons. It costs less to train maintenance men and they become more efficient working on standardized equipment. It also cuts down on needed stocks of repair parts. One West Coast airframe plant reduced its stocks of casters and wheels by 75% by standardizing on one type.

Materials handling planners often face the alternative of floor handling as against overhead handling. Even before deciding which is better, they first must check to see if both are possible.

Finding the better method hinges first on the manufactured product itself . . . production rate, quantity on order, tools, jigs and fixtures, and so forth. Next come considerations of floor layout and building condition. That involves space limitations, building clearance heights, and ability of building to support overhead handling devices.

Protection in Handling

Materials handling equipment is expected to move parts without scratching or damaging them. It's serious business in aircraft plants since surface scratches can cut down airplane air speed.

Basic scratch-prevention material used is kraft paper, interleaved between parts. Padded fixtures, jigs, slings, and carts also help. In some cases, strippable plastic coatings do a job. For example, they help prevent obliteration of instrument panel lettering during assembly. A wash-off coating recently has been introduced.

One company investigated strippable plastic coatings and found them useful in preventing only minor abrasions in handling. Careful handling, it was found, reduced scratch occurrence about as much as the coating. For most applications, the protection received from the coating is negligible

compared with the cost of applying and removing the coating. Then too, workers may tend to be less careful in handling if they think the coated part is fully protected.

(Report on which this article is based is available in full together with the eight other secretaries' reports from this Production Forum as SP-304, from SAE Special Publications Department, 29 W. 39th St., New York 18, N. Y. Price: $2.00 to members, $4.00 to nonmembers.)

Instrumentation . . .

. . . for flight test has made rapid advance, but new instruments having greater accuracy, reliability, and flexibility are needed for future work.

Based on paper by **W. Lavern Howland** Lockheed Aircraft Corp.

A great many new type instruments will be needed to carry out flight test work in the future. Among the most important may be mentioned the following:

There is needed first of all an improved type of tachometer which can be used in flight and have an accuracy of at least 0.1%. Following this there should be a new type of flowmeter having a very high degree of accuracy, say of the order of 0.25%. It should be unaffected by vapor and fluctuation in rate and should be capable of indicating rate as well as total fuel flow, and it should have a low pressure drop.

A good simple digital indicator using standard type transducers is also needed. At the present time there are a large number of well developed and proven transducers on the market, but the number and type of indicators which can be used with them is extremely small. The need is for both a panel mounted digital indicator and an analog indicator. There is call, too, for an airspeed indicator and an altimeter with an electrical output which will have the same degree of readability as standard instruments on a standard oscillograph.

Another instrument which will be sought is a high speed temperature recorder which will replace the standard Brown flight recorder. The Brown instrument has done a marvelous job for the past 10 or 12 years and it will probably continue to do a good job for a number of years to come. However, the number and magnitude of the temperature surveys conducted and their importance in future airplanes is such that an instrument is needed which will record the data in a better form for automatic reduction and plotting. A similar device is needed for pressure surveys.

A general and very broad type of new instrument required is one which will help the engineer solve various dynamic problems. Instruments of the type that can measure transfer function, phase angle, and frequency distribution are needed.

The development costs in elapsed time required on a prototype airplane are greatly affected by the type and amount of instrumentation used. The magnitude of the data recorded and problems and factors requiring study indicate that complete automatic data recording and analysis must be accomplished in the future in order to shorten development time. (Paper, "Flight Test Instrumentation Status" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Based on discussion

Comment: (George Keinath, consulting engineer) The multiframe sweep balance recorder records temperatures and pressures up to a hundred times faster than the usually used instruments.

The sweep balance recorder is a facsimile recorder with the transmitter on the same shaft as the receiver. A measuring eye scans the whole length and range of a circular potentiometer. When the balance point is passed, the eye gives a current impulse through a high-speed electronic null relay. Data appear in separate frames, not in galaxies.

Speed between the marker stylus and the chart may be as high as 240 in. per sec. Time needed to mark the volt-sensitive paper is as short as 20 microsec. Only the reaction time of the paper limits the speed of sweep balance recording. With four channels, 400 measurements per sec are possible.

Sweep balance recordings may be made on film. One such recorder planned for commercial airplanes records 18 variables for a full week.

Question:

"Can you tell us if any progress is being made toward getting digital results from the various instrumentation directly in the airplane?"

Answer:

"It is felt that present development should be mainly directed to improvement of transducers. Better transducers are needed in order to make full use of presently available recording methods."

Question:

"Has anybody considered suspending instrumentation on a balloon and flying the airplane in the vicinity of the balloon for the purpose of the calibration of the airplane's instruments?"

Answer:

"Yes, that is one of our methods of calibration."

Question:

"What do you believe to be the present and future accuracy requirements for aircraft instruments?"

Answer:

"The accuracy must be as high as possible to attain, and in scarcely any item is more than 1% permissible. Many items require accuracy nearer 0.1%."

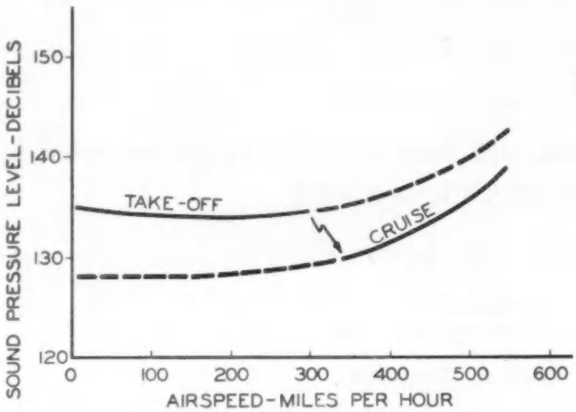


Fig. 1—Propeller noise (first harmonic) of a turboprop transport would drop off slightly during the take-off run, experience a sudden drop as the plane gains altitude, then rise sharply with increases in high-altitude flight speed—as shown by the solid line above. (These curves were figured on the basis of a 4-blade, 17.5-ft propeller with 10.75 ft tip clearance. Take-off conditions: 12,000 hp, 770 fps rotational tip speed, sea level. Cruise conditions: 4000 hp, 750 fps rotational tip speed, 40,000 ft)

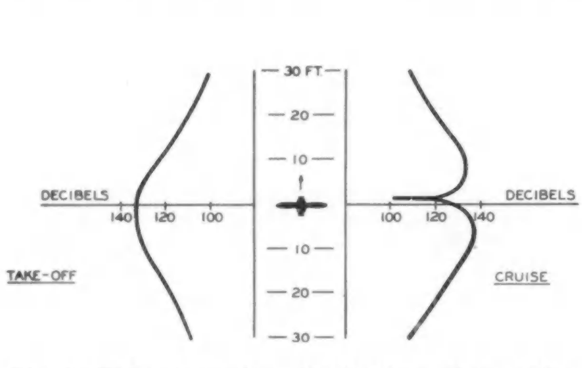


Fig. 2—This shows the distribution of propeller noise (first harmonic) along a turboprop fuselage wall under conditions of take-off and cruise. Note that at take-off, the maximum noise level occurs very near the plane of rotation of the propeller. Under the cruise condition, however, the noise level peaks fore and aft of the plane of propeller rotation. (These curves were figured on the basis of a 4-blade, 17.5-ft propeller with 10.75 ft tip clearance. Take-off conditions: 12,000 hp, 770 fps rotational tip speed, sea level. Cruise conditions: 4000 hp, 750 fps rotational tip speed, 40,000 ft, 545 mph)

Turboprop Propeller

UNTIL field tests prove otherwise, it appears that it will be possible to figure out on paper the quietest propeller for a particular turboprop. What's more, paper evidence adds solid support to the theory that propeller noise increases with in-flight speed. Perhaps even more important, it indicates that propeller noise of future turboprop transports won't be any greater than that of today's large reciprocating-engine airliners.

In short, calculations of propeller noise made by turboprop and piston-engine airplanes during various operating conditions indicated that:

- It will be possible to figure out on paper the "quietest" propeller for a particular turboprop. (This will be done by varying such things as tip speed, diameter, and number of blades.)
- At air speeds exceeding 300 mph, propeller noise increases appreciably with air speed at high altitude. At sea level and relatively low velocities, however, there is a tendency for propeller noise to decrease with increasing forward speed.
- Except for areas within a few thousand feet of the take-off runway, the maximum overall community noise of turboprop transports need not exceed that of present-day reciprocating-engine transports. As for cabin noise in the turboprop, it will be less when taking off . . . and not perceptibly greater when cruising at altitude.

Perhaps even more important than these conclusions, however, is the fact that they could be drawn from calculating-machine results. For it wasn't until 1949, when an expression was developed for the rotation component of in-flight propeller noise, that such noise calculations could be made.

Before going into the details of what the paper evidence showed, it should be mentioned that only propeller **rotation noise** was taken into consideration. That's because the other component of propeller noise—vortex noise—is relatively small except for conditions of engine idle.

Noise Needn't Be a Bugaboo

Joern Schmey and W. H. Clark, Curtiss-Wright Corp.

Based on paper "Control Systems and Noise Problems for High Speed Propellers" presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1953.

It should also be pointed out that the analysis was confined to the first harmonic component of propeller rotation noise. There are a number of reasons for this. For one thing, at high forward-speed conditions, calculation of sound pressure amplitudes for harmonics higher than the fundamental frequency becomes a very lengthy procedure. For another, the first harmonic is usually of the highest intensity and the most difficult frequency to control.

What Controls Turboprop Noise

Now, keeping these things in mind, let's take a look at what the calculations showed to be the:

Effect of forward air speed on propeller noise: This is shown by the solid line in Fig. 1. (The noise levels indicated by the broken lines are of academic interest only.)

Starting with the take-off run, the propeller noise level of a turboprop drops slightly at first; then increases gradually as the plane approaches 300 mph—take-off speed. Following this, at high-altitude level flight and cruise power, it increases with air speed from about 129 db at 300 mph to 139 db at 545 mph. The discontinuity in the solid curve at 300 mph represents the change that takes place with reduction in engine power and propeller tip speed and increase in altitude in climbing to 40,000 ft.

Effect of air speed on distribution of propeller noise along turboprop fuselage wall: As shown in Fig. 2, at the zero forward speed or take-off condition, the maximum noise level occurs very near the plane of rotation of a propeller with a fuselage clearance of 10.75 ft. This peak is relatively broad and falls off almost symmetrically with distance forward and to the rear of the propeller. (This is in good agreement with experimental results.) For the condition of high-speed cruise, the noise level peaks fore and aft of the plane of propeller rotation. While under the conditions chosen, these peaks differed in magnitude by only 5 db and the larger one was behind the propeller, this is not always the case. With

Prop Control, Like Noise, Is No Barrier for Turboprops

JUST as there's no cause for alarm about propeller noise of future turboprop transports, so it is with propeller control systems.

That's because there is no supersonic control problem beyond that already encountered in present transonic and subsonic turboprops. Propeller parameters and engine characteristics which are important to control vary only slightly at sonic and moderate supersonic speeds.

Thus today's propeller control mechanisms will be entirely suitable for tomorrow's supersonic turbine-propeller aircraft.

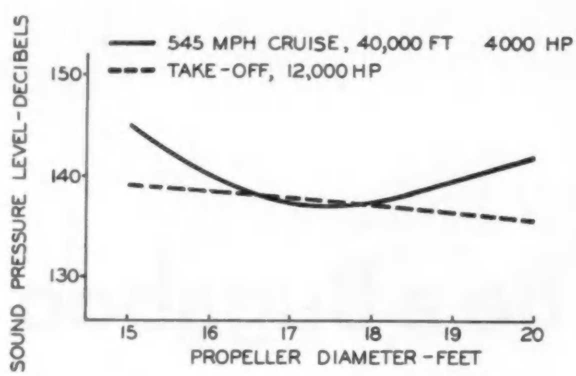


Fig. 3—Turboprop propeller noise (first harmonic) at zero air speed and take-off power decreases almost linearly with increasing propeller diameter, assuming tip clearance remains constant—as shown by broken curve above. At the high-speed cruise condition, the noise level falls off rapidly with increasing propeller diameter to a certain point, then rises with further increases in diameter. (These curves were figured on the basis of a 4-blade propeller, with a rotational tip speed of 900 fps and 10.75 ft tip clearance)

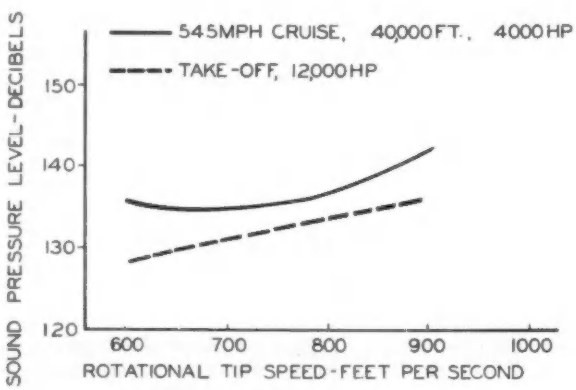


Fig. 4—Turboprop propeller noise (first harmonic) at zero air speed and take-off power increases almost linearly with tip speed—as shown by the broken curve above. At flight speed, however, propeller noise first decreases, then increases with increasing tip speed. (These curves were figured on the basis of a 4-blade, 20-ft propeller with 10.75 ft tip clearance)

other propeller sizes and operating conditions, the larger peak may occur forward of the propeller . . . and noise levels differ by 20 db or more.

Variation of propeller noise with propeller diameter under take-off and cruise conditions: Turboprop propeller noise at zero air speed and take-off power decreases almost linearly with increasing propeller diameter, assuming tip clearance remains constant. (This is shown by the broken curve in Fig. 3.) At the high-speed cruise condition, the noise level falls off rapidly with increasing propeller diameter to a certain point; then rises with further increases in diameter. Of course, this optimum propeller diameter from a "cruise" noise-reduction standpoint will vary, depending on propeller parameters and operating conditions. Also, it should be noted that the most desirable propeller for "quiet" operation at static conditions is not necessarily the best in high-speed flight.

Variation of propeller noise with propeller rotational tip speed under take-off and cruise conditions: Turboprop propeller noise (of a 4-blade, 20-ft diameter propeller) at zero air speed and take-off power increases almost linearly with tip speed. (See broken curve in Fig. 4.) At flight speed, however, propeller noise first decreases, then increases with increasing tip speed. This suggests the possibility of designing a propeller for minimum noise generation at frequently used flight conditions.

Variation of propeller noise with number of blades on the propeller under take-off and cruise conditions. For zero or near zero air speed, increasing the number of blades in a propeller decreases propeller noise. (See Fig. 5.) For the parameters chosen, the noise reduction amounts to only 2 db for each additional blade, but at lower tip speeds noise reduction is considerably more. At the high-speed cruise condition, the first harmonic of propeller noise increases about 1 db for each blade added to a propeller. (However the variation of this 1 db increment with tip speed needs further study.) For intermediate air speeds, the noise level variation with blade number will lie between the extremes for take-off and cruise.

Turboprop versus Piston Engine

Thus, these results indicate that it will be possible to figure out on paper the "quietest" propeller for a particular turboprop. Next, the natural question is, "How will the noise level of such propellers compare with that of propellers on reciprocating-engine transports?"

Further "paperwork" produced this answer: Except for areas within a few thousand feet of the take-off runway, the maximum overall community noise (all harmonics) of turboprop transports will not exceed that of today's higher powered piston-engine aircraft.

Fig. 6 shows this graphically. The bullet-shaped contours indicate the ground area adjacent to the take-off runway that is exposed to noise levels of 80, 100, and 120 db. In the immediate vicinity of the runway, the conventional airplane has a slight edge since the 120 db sound pressure level encloses a slightly smaller area. However, as the distance

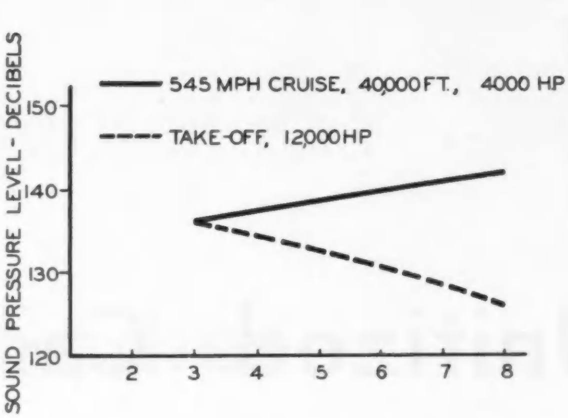


Fig. 5—Turboprop propeller noise (first harmonic) at zero air speed and take-off power decreases as the number of blades in a propeller is increased—as shown by the broken curve above. At the high-speed cruise condition, propeller noise increases slightly for each blade added to a propeller. (These curves were figured on the basis of a 17.5-ft propeller, with a rotational tip speed of 750 fps and 10.75 ft tip clearance)

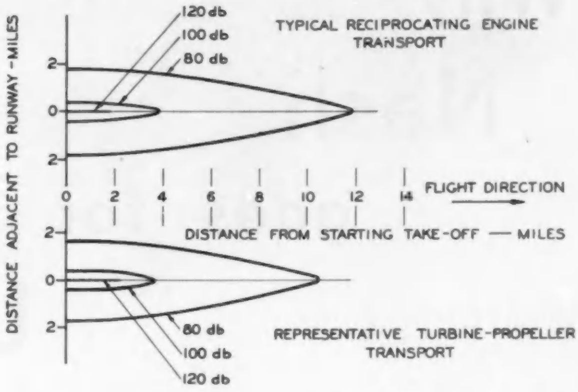


Fig. 6—Except for areas with a few thousand feet of the take-off runway, the maximum overall community noise (all harmonics) of turboprop transports will not exceed that of today's reciprocating-engine aircraft

from the take-off path increases to where the noise level is only 100 db, the turbine-powered transport is on a par with its piston-engine counterpart. And at the 80 db level, it exhibits a small improvement in the size of the ground area saturated. Note, too, that the greater rate of climb of the turboprop aircraft is reflected in the shorter length of the 80 db "bullet."

Now, taking this comparison a step further, let's see what was found when we compared propeller noise (of each type of aircraft) at the fuselage wall and at a distance 2000 ft from the propeller.

The results of this study are shown in Fig. 7. The maximum noise levels along an imaginary fuselage wall are summarized in the first two pairs of bars. In cruise, the turboprop noise is seen to exceed that of the conventional installation by less than 3 db—a barely significant amount from a practical standpoint. At take-off, on the other hand, the turbine propeller has the advantage by 5 db. As the distance from the propeller is increased to 2000 ft, however, the turboprop propeller noise level again exceeds that of the reciprocating-engine propeller. (See third set of bars.)

Actually, the overall community noise at 2000 ft is about the same for both types of aircraft (as shown by the bullet-shaped contours in Fig. 6). That's because the strong high-order harmonics of piston-engine propellers make up for the higher first harmonic levels of turboprop propellers.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

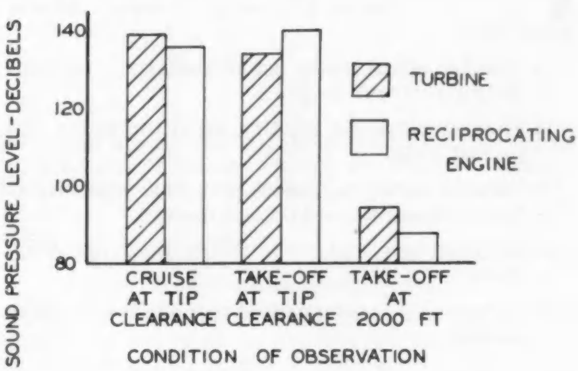


Fig. 7—This shows a comparison of the propeller noise levels (first harmonic) at the fuselage wall and at a distance of 2000 ft from the propeller for a turboprop and piston-engine aircraft. In cruise, the turboprop noise level is slightly greater at the fuselage wall; at take-off, it is slightly less. At a distance of 2000 ft from the propeller, the turboprop noise level exceeds that of the reciprocating-engine propeller by a small amount, but this is only true for the first harmonic. (These curves were figured on this basis: **Turboprop:** 4-blade, 17.5-ft propeller with a 10.75 ft tip clearance. Take-off conditions: 12,000 hp, rotational tip speed of 770 fps, sea level. Cruise conditions: 4000 hp, rotational tip speed of 750 fps, 40,000 ft, 545 mph. **Piston-engine:** 3-blade, 15-ft propeller with a 1.5 ft tip clearance. Take-off conditions: 3250 hp, rotational tip speed of 1000 fps, sea level. Cruise conditions: 2000 hp, rotational tip speed of 825 fps, 20,000 ft, 320 mph)

Why Nash goes for Unitized Car

UNITIZED car bodies offer many practical advantages over chassis frame-type bodies. Among these are:

- Greater efficiency in use of materials, particularly structural steel.
- Greater torsional rigidity, resulting in an improved ride.
- Greater safety to passengers, due primarily to better absorption of impact energy.
- Reduced body noise due to one-piece construction.
- A structure better adapted to modern full-width bodies.

More Metal Put to Work

Greater efficiency in use of materials, particularly steel, comes largely from elimination of the conventional chassis frame, which in American cars normally weighs from 200 to 275 lb.

Part of this saving must be put back into the unitized body in the form of added bracing, attaching brackets for rear suspension units, and so forth. But approximately 60% of the total weight of the usual frame and body mounting parts can be saved. In addition, economies can be effected in engine, drive system, suspension, brakes, and axles as the direct result of weight saving elsewhere.

The overall result is that the total weight saving in a unitized-body car is nearly that of the usual chassis frame.

Part of this weight saving results from effective use of monocoque construction, which simply means use of the outer skin of the body for load-carrying functions. The outer skin is stressed and put to work by adding to the strength and rigidity of the box-section inner structures.

Nearly all Nash body stampings (except hood, doors, and trunk lid) are used in this manner. Most important, however, are the roof section, the front and the rear wheel housings and fenders, and the dash or fire wall. Skin-stressed outer panels combine with the inner framing to which they are solidly welded to give a structure rigid in all directions.

Thus, a greater proportion of the body steel in a unitized car is put to work—less metal goes along merely for the ride.

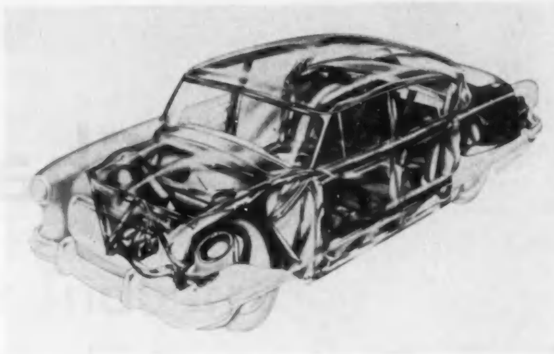
Greater Torsional Rigidity

Unitized construction is particularly advantageous in that it offers high initial resistance to torsional deflection.

The usual automobile body, rubber-mounted to a chassis frame, can be arranged to offer comparable rigidity when deflected through relatively large angles. Under these conditions, the rubber mountings are compressed solid and the frame and body act as a more or less single structural unit.

For relatively small deflections, however, the chassis frame alone resists torsional forces. The resulting rigidity is only a small fraction of that supplied by either a good unitized body or a separate frame and body acting solidly together. Ride and general car feel are adversely affected, since many of the deflecting forces are insufficient to pick up the inherent rigidity of the usual body through its flexible mountings.

When both front or both rear wheels hit an irregularity together, any car is subjected to bending stresses. In a car with a separate chassis frame, the bending stresses may be concentrated at the forward mounting point of the body to the frame, where an abrupt change in section height normally occurs. With a unitized body, on the other hand, a rugged A-structure joins the body dash to the front suspension.



Bodies

L. H. Nagler, Nash-Kelvinator Corp.

Excerpts from paper "Unitized Body Design" presented at SAE Mid-Michigan Section Meeting, Owosso, Michigan, Jan. 25, 1954.

Hence, a car with a well designed unitized structure feels more stable on the road, and gives a better ride, than a comparable car with separate frame and flexibly mounted body.

Safety Bonus for Passengers

Unitized structure also provides greater safety for the passengers.

This results partly from the two massive "A" structures in front of the passengers, extending around each side of the engine. Added metal at these areas guards passengers against head-on and front corner blows.

In addition, the longitudinal members of the floor structure, located between the wheels near the outer edge of body, provide greater protection against collisions from the side. By contrast, the usual chassis frame, with main side rails well inside the wheel line, offers little resistance to this type of damage unless the body side panels are collapsed far enough to pick up the frame side rails.

Recent airplane experience indicates that judicious distribution of light metal sections, as in the unitized design, more effectively protects passengers. By allowing metal at the point of impact to crush without abrupt increase of resistance, passengers are better protected against sudden and violent stops.

In some accidents the extra compressive strength of a chassis frame in the longitudinal direction may increase deceleration rates to a point where passengers are thrown violently against seats, instrument panel, glass or other interior body parts. With unitized structure, however, more gradual absorption of the blow, with accompanying reduced deceleration rates, saves lives as evidenced by numerous accident records.

Fewer Squeaks and Rattles

With the increased torsional rigidity of the unitized car structure, there is less tendency for structural squeaks and rattles to develop.

There are no flexible body-to-frame mountings to loosen and develop squeaks; no separate riveted chassis frame to loosen.

The net result is that a unitized car stays quieter and maintains its original structural rigidity longer.

Adapts Easier to Full-Width Bodies

The American style trend toward wider bodies in recent years has complicated frame design. When bodies were comparatively narrow, mounting them to a chassis frame was comparatively simple; the body sills could easily be made just as wide as the frame. Now, however, it is necessary to furnish long outriggers, with numerous cross bracings and reinforcements, to provide an acceptable body-mounting system.

The unitized design avoids all this complication and extra weight.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Change Control

CHANGE control provides an overall plan and schedule for making product changes with a minimum of cost and confusion.

It involves different methods of handling routine and emergency changes; accurate classification of the different kinds of changes; and well planned techniques for coordinating the varied groups and processes involved in getting the changes made. Its functioning touches almost every phase of a prime contractor's organization—and reaches out to coordination in subcontractor operations as well.

Different handling is given to routine and "expedited" changes in all aircraft plants. The types of changes to which the routine and expedited processes are applied are four in number: safety, mandatory, negotiated, and miscellaneous.

Safety and mandatory changes are almost always in the "expedited" category, it appears. The negotiated Engineering Change Proposal or Master Change Request usually is requested by the customer, who establishes the priority for the change.

Miscellaneous changes, usually being minor in character, tend to fall into the routine category. Usually they involve an improvement in assembly, fabrication, or installation techniques and are made effective on a certain block airplane in such a manner that the schedule and cost are not impaired.

All types of change are scheduled through the agencies required to handle them. A Change Control Board or Group coordinates them with the Schedules Department.

The customer has to be given the cost and schedule effect of the ECP and MCR types of change, and has to give his approval prior to the start of formal engineering on them. When the category and effectivity set by the Change Control Board isn't satisfactory to the Engineering Department and/or the customer, coordination usually is effected at the executive level with the three groups participating.

Usually, however, the Engineering Department establishes priority of changes—and through coordination and the reason for the change—establishes the category and the desired effectivity.

The Change Control Board is responsible for keeping all concerned agencies cognizant of schedule requirements and of the status of changes currently in process.

Routine changes usually originate in the Tooling Department or in some shop department. Such changes usually are made effective on a block or lot of airplanes scheduled far enough in the future to allow normal flow time through engineering, material, tooling, and shop operations.

Expedited changes, on the other hand, usually are made effective immediately by engineering or executive decision. With such changes, many parts usually must be made with either a minimum of tools or no tools at all. So, the company's experimental and development departments often are called on to do the job. Expedited changes require much personal handling by people in each of the groups involved. They almost always add costs. Often, too, delivery schedules are delayed to a point where complete rescheduling of the program is required.

It is common practice, discussion revealed, to schedule orders due-dated on expedited programs at their true due date. This is to assure shop loading in the proper priority sequence. Such sequence is so vital, many reported, that the practice is justified even though it necessarily makes an order past-due upon release.

A Subcontracting Department (part of the Purchasing Department) of the prime contractor company usually is responsible for keeping subcontractors up to date on changes. In the prime contractor's organization, changes are released

Change Control Panelists . . .

N. H. Shappell, Leader
Douglas Aircraft Co., Inc.
Santa Monica

A. F. Kitchin, Coleader
Rohr Aircraft Corp.
Chula Vista

D. C. MacArthur, Secretary
Douglas Aircraft Co., Inc.
Santa Monica

J. R. Allen,
Douglas Aircraft Co., Inc.
Tulsa

J. C. Derse
AiResearch Mfg. Co.
Los Angeles

H. E. Herdrich
Northrop Aircraft, Inc.
Hawthorne

J. F. Lashley
Lockheed Aircraft Corp.
Burbank

Practices

in the Aircraft Industry

. . . a summary of current practices and procedures now common within aircraft plants – and by aircraft plants in subcontractor relationships.

D. C. MacArthur, Douglas Aircraft Co., Inc.

Based on the secretary's report of Panel on Change Control held as part of the SAE Production Forum at the SAE National Aeronautic Meeting, Los Angeles, Sept. 30, 1953.

from the Engineering Department, processed by the Planning Department and given to the subcontractor by the Subcontracting Department.

Other potent change control relationships, however, usually exist and function between the prime and the subcontractor organizations.

Some subcontractors maintain a full-time representative in the prime contractor's plant. In such cases, the subcontractor's representative is often an actual member of the prime contractor's Change Control Board . . . especially when he has authority to commit the subcontractor as regards effectivity.

Sometimes—when changes may jeopardize schedules—a prime contractor's change control representative and one of his group charged with subcontractor manufacturing contacts may go together to the subcontractor's plant to negotiate effectivity and prices. (A subcontractor is usually allowed one week for verification of a change.)

On expedited changes, the prime contractor almost always has to rework parts on hand—and sometimes parts yet to be received from the subcontractor.

Some subcontractors prefer to have expedited changes handled by their representative in the prime contractor's plant and a prime contractor's representative in their plant.

Verification of the fact that the changes have been made by the subcontractor is almost always the responsibility of the prime contractor's Inspection Department. This department coordinates planning paper with engineering drawings for the parts involved.

Considerable detail is usually involved in accomplishment of the verification process. For example:

The Planning Department usually furnishes the shop and the Inspection Department with paper which notes the applicable engineering drawing or letter change; also the applicable processing and manufacturing information. This paper is checked with the engineering drawings by the Inspection Department and recorded as being the proper change. It is then maintained as a permanent record by the various inspection departments. Also, it is used by the customer's inspectors to verify that his airplane is built to include the latest change.

Major ECP or MCR changes are recapitulated on the inventory record (Form 263) for military aircraft—and on the packing sheets for commercial customers. (Form 263 and the packing sheets are often prepared by, and always verified by, the prime contractor's Inspection Department.)

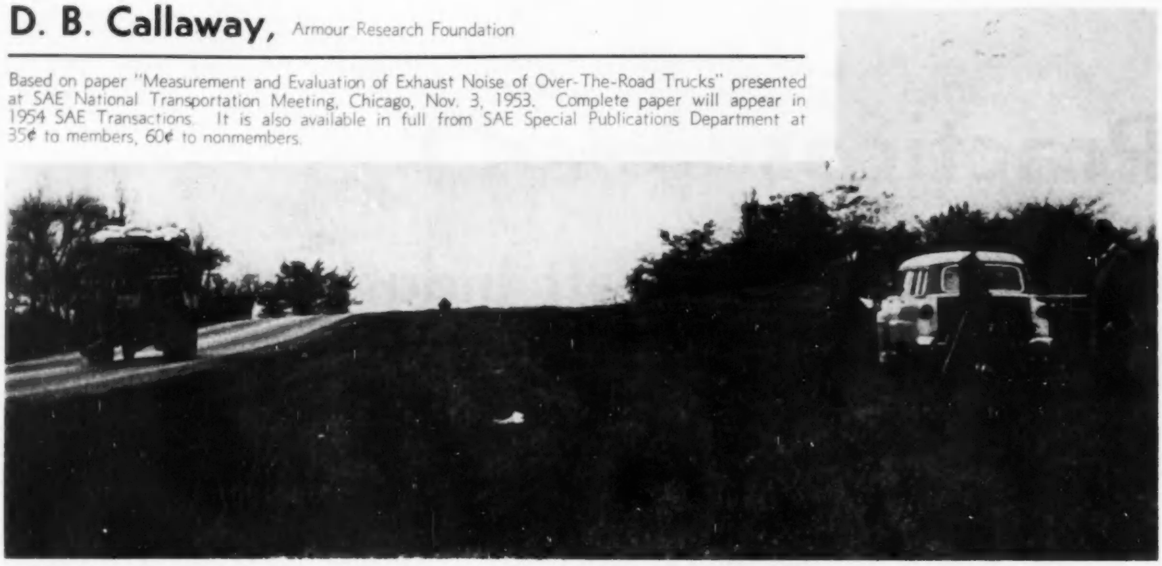
The prime contractor relies on his source inspector at the subcontractor plant to verify that all units produced are to the proper change. Then, the prime contractor's plant checks them again upon arrival there for change effectivity. (Serial numbers placed on data plates by the vendor usually indicate change effectivity on purchased parts and items.)

Sometimes color coding denotes parts to latest change, parts which may be used as part of a winterization kit, parts which may be used in sea rescue kits, or in tropical climates.

(The full text of this report, along with that of the secretaries' reports of the other nine panels at this Production Forum is available from SAE Special Publications Department, as SP-304. Price: $2.00 to members, $4.00 to nonmembers.)

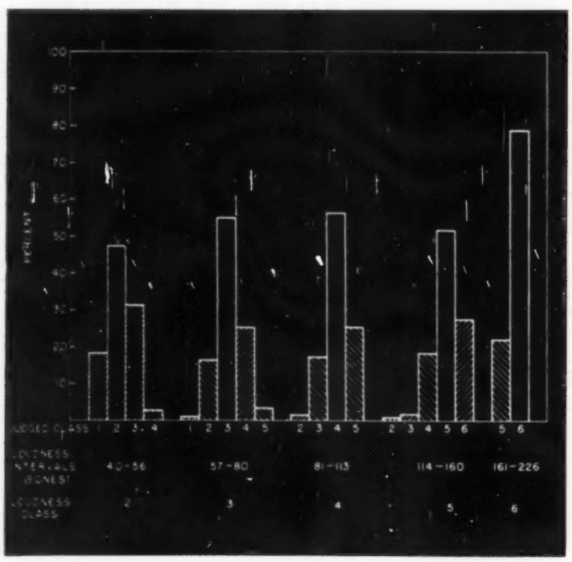
D. B. Callaway, Armour Research Foundation

Based on paper "Measurement and Evaluation of Exhaust Noise of Over-The-Road Trucks" presented at SAE National Transportation Meeting, Chicago, Nov. 3, 1953. Complete paper will appear in 1954 SAE Transactions. It is also available in full from SAE Special Publications Department at 35¢ to members, 60¢ to nonmembers.



1 **Microphone** 50 ft from road picks up noise as truck climbs 5% grade. Hood over mike prevents wind interference. Test location is free of buildings, reflective banks, and off-road noise sources. Noise is recorded on a tape recorder. Later, in lab, impulse from . . .

. . . Measuring Truck

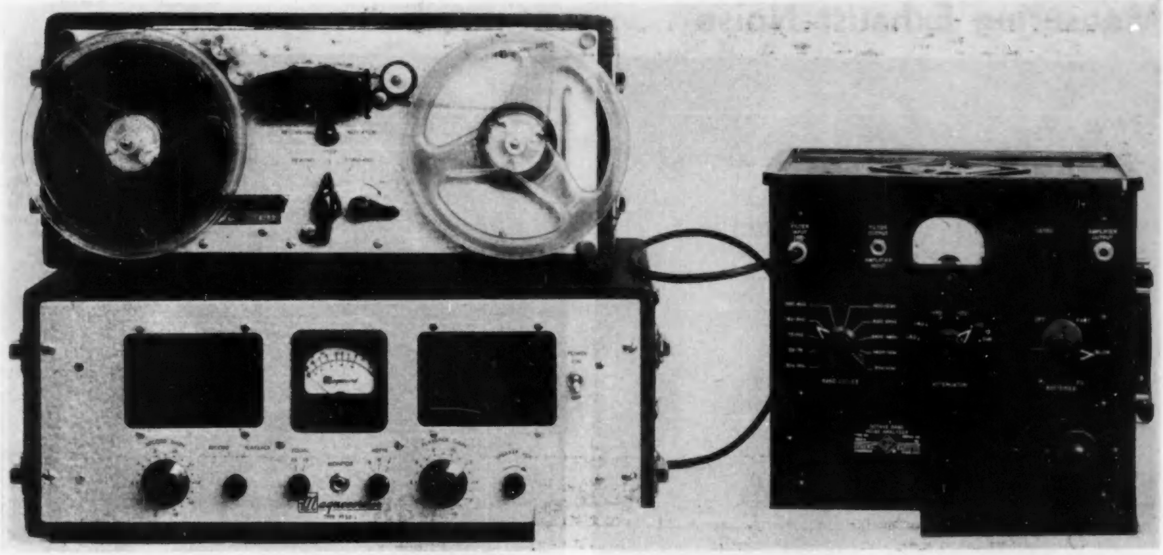


3 **Instruments agree with listeners.** Investigators made sure of that when they began this American Trucking Associations-sponsored project. They played tapes recorded near Chicago to a panel of listeners and asked them to place each noise in one of six classes according to its loudness.

As the chart shows, half or more of all judgments were correct, and about 98% were within one class of being correct.

The six classes were set up this way: Maximum and minimum (actually a passenger car) noises recorded during the test were played. Listeners were told that these represented the upper part of Class 6 and the lower part of Class 1. (Classes 7–10 were reserved for anticipated louder noise from bigger West Coast trucks.)

Listeners tended to make their scale divisions in about 40% increments of loudness. So loudness intervals were adopted accordingly.



2 **Tape recorder feeds a frequency analyzer** incorporating a sound level meter. Sum of sound levels measured in sones for all octaves between 10 and 20 cps gives single number for loudness. This is the method Armour Research Institute developed, at ATA's request, for . . .

Exhaust Noise

4 **West Coast trucks are noisier.** They averaged 55% louder than those of the Middle West, better than one loudness class. Midwest figures were taken on 97 trucks chosen at random, most of them on Route 66 about 20 miles southwest of Chicago and a few on Route 83 on a 4% grade. West Coast test location was on U.S. Route 99, near Portland; 94 trucks were measured.

Loudness units used were sones because sones correlate better with judged class than phons or decibels do.

Trained technicians can test a truck in 5 or 10 minutes, but the equipment is not suited to use by law-enforcement officials for on-the-spot checks of individual trucks.

It would be more practical to standardize a muffler testing procedure, and then require each truck to be equipped with a muffler (1) of a design qualified under the test and (2) in good condition. Officials could easily check these two points.

Armour researchers found that . . .

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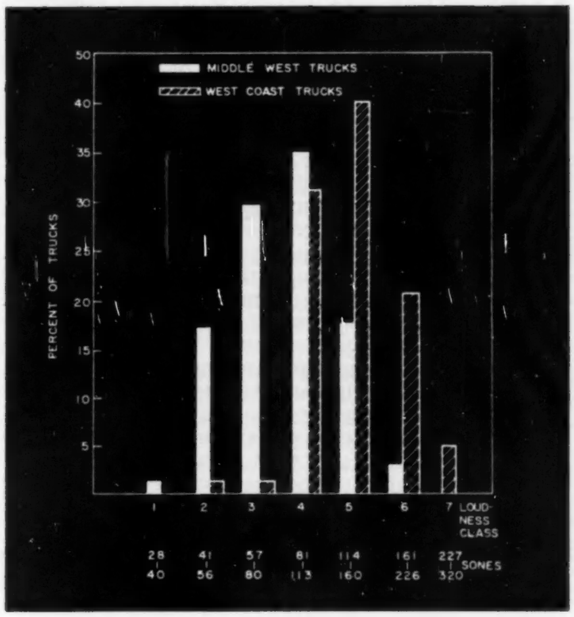
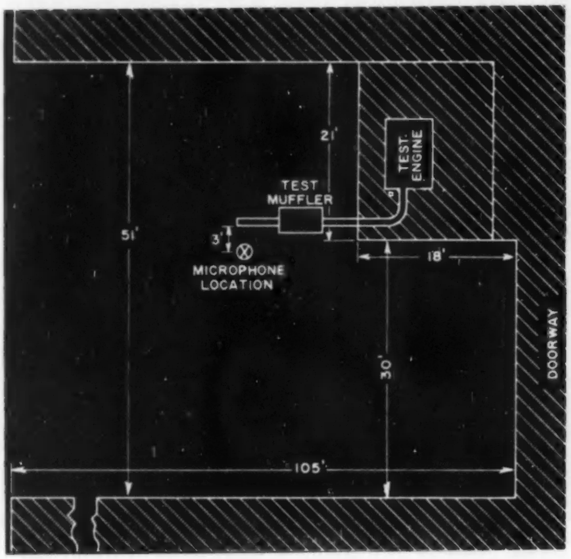
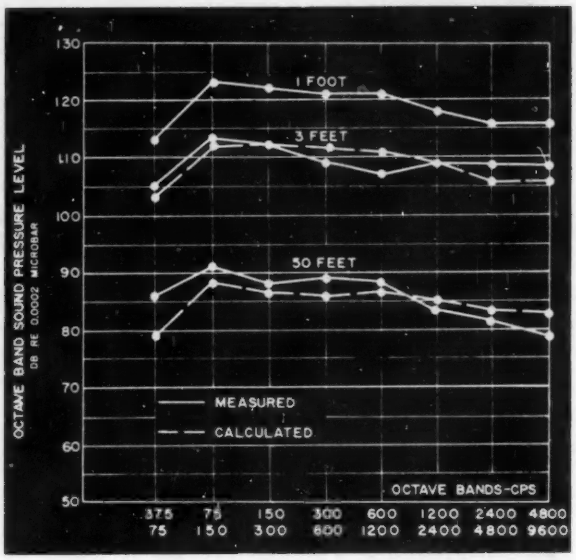


Measuring Exhaust Noise . . . continued



5 **Test set-ups** like this yield data from which highway exhaust noise can be accurately calculated. Of course, with well muffled exhaust, running noises also are detected in highway measurements. But . . .



6 **Measured and calculated loudness** of exhaust alone agree well. These calculations were made from data taken 1 ft from the tail pipe with a chassis dynamometer. Engine was a Buda DAS 280-hp 6-cylinder diesel at 1800 rpm, full load.

Engineering Aptitudes . . .

. . . demanded by industry are different for each phase of engineering. Distinction is made particularly on functions and work attitudes.

Based on paper by **C. W. Frederick** General Motors Corp.

AN engineering organization is usually composed of five parts—advance design, product design, testing, production engineering and field service engineering. The engineers in each of these divisions have certain definite functions to perform.

Advance design demands that the engineer: (1) Grasp the nucleus of proposed ideas and translate those ideas into an actual creation capable of demonstrating its feasibility. (2) Refrain from resentment when his creation is tempered by redesign into a more practical unit.

Product design demands that the engineer: (1) Redesign, as necessary, the advance engineers' design into a simple, foolproof, salable product. (2) Retain the essence of the advance design group's proposed performance. (3) Coordinate their design with production engineering so that machinery and equipment can be used with maximum productive capacity.

Testing demands that the engineer: (1) Prove the soundness of the design engineers' work and supply information which cannot be obtained on drawing boards.

Production engineering (pre-production) demands that the engineer: (1) Cooperate with the product design group during design stages and assist in getting preliminary costs for guidance. (2) Follow tests so that inherent weaknesses can be corrected or at least known prior to production. (3) Recommend changes for easier manufacture or a more economical product. (4) Determine if the new design can be made on equipment available.

After the article is placed in production, production engineering has to: (1) Determine if product meets performance, durability, and cost requirements. (2) Analyze requirements, seeking improvement in performance and durability, and reduction in cost. (3) Insist that unbiased facts regarding performance, durability, and cost be the only criteria used to determine need for change. (4) Determine the effect of tolerances, materials, and processes on performance, durability, and cost.

The field engineer must be able to detect failures occurring during the warranty period, or after high mileage and/or long periods of time if they are occurring under abnormal operations such as overload, and their frequencies. When difficulty is met with on an assembly, he must be able to figure out what part failed first and under what conditions. Doing his job thoroughly will save a great deal of money for the company and greatly improve customer relations. (Paper "What Engineering Management Requires of the Engineer" was presented at SAE Kansas City Section, Oct. 1, 1953.)

Ford's Got a New V-8

Robert Stevenson, Chief Engine Engineer, Ford Motor Co.

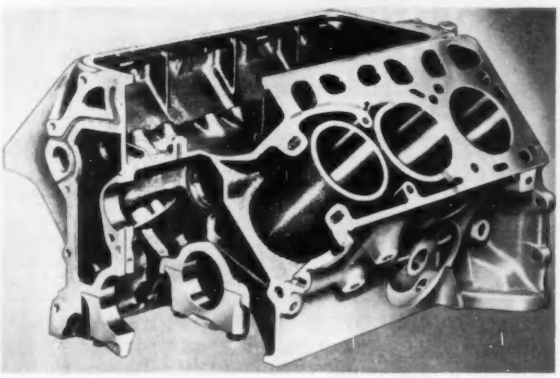
Based on paper "The New Ford V-8 Engine" presented at SAE Annual Meeting, Jan. 13, 1954. Complete paper will be printed in full in 1954 SAE Transactions. Multilithographed copies can be obtained from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.

ESTABLISHING the number and arrangement of cylinders for the new Ford engine was not a difficult decision to make. The V-8 engine had already earned world-wide acceptability in our vehicles. We had many years of V-8 manufacturing and engineering experience. Finally, there was the comfortable knowledge that an ever-increasing number of manufacturers have recognized the V-8's inherent short rigid structure and characteristic smoothness at all speeds and loads.

With these advantages already assured, we set about to achieve as major design aims:

- Displacement, package size, and weight approximately equal to that of the L-head V-8.
- Greatest possible structural rigidity, to maintain a high standard of smoothness with probable future compression ratio increases.
- A very short stroke, to increase mechanical and thermal efficiencies.
- An overhead valve arrangement, to permit maximum volumetric efficiency, if required by future increases in compression ratio.
- Maximum mechanical simplicity to allow for manufacturing economies.

In addition to these major design considerations, there were many other objectives which had to be met, such as: lower valve temperatures, rotating valves, full-flow oil filtration, thorough engine ventilation, a single water pump, chain-driven camshaft, combustion chambers with maximum quench areas, and, of course, more horsepower and torque.



CYLINDER BLOCK in the new Ford V-8 engine is a one-piece casting of high-grade iron alloy, designed for unusually high strength and great rigidity. This cutaway view shows one of the five bulkheads which stiffen the structure and serve as supports for the crankshaft and camshaft bearings. Cylinder-head attaching bolt bosses are formed in the outside walls to prevent cylinder-bore distortion when the heads are pulled down tightly. Cylinder bores are attached only at the top and bottom decks, and are completely surrounded by the cooling water over their entire lengths.

Why a New Ford V-8?

In 1948, Ford decided to convert its engine plant facilities to accommodate modern transfer equipment and more complete automation.

Since major tooling expenditures require a minimum of eight years for amortization, it was decided that a new engine would best meet the requirements of future improvements in fuel and higher compression ratios.

Consequently, the engineering staff was asked to design a new engine that would meet these requirements, as well as those of the vehicle planned for release in 1954.

For obvious reasons, it was also necessary to design into this new engine a high degree of adaptability, to permit future changes as technical knowledge increased or economic conditions dictated, without major changes in tooling or facilities.

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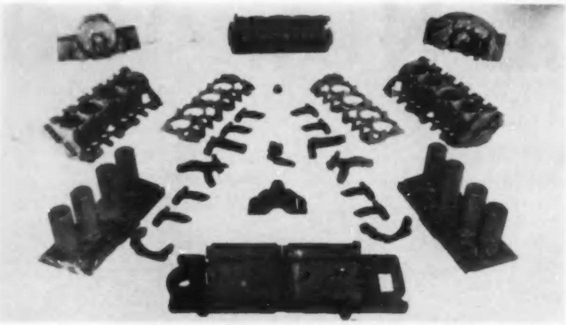
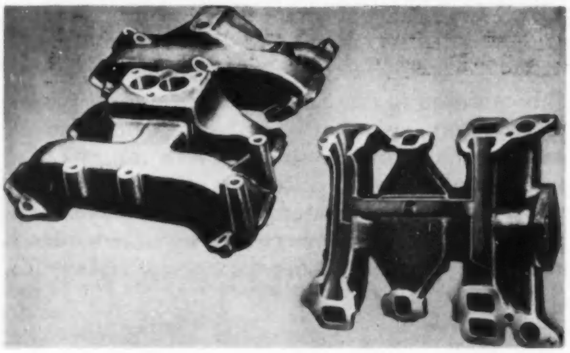
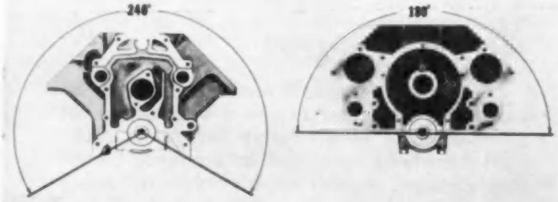


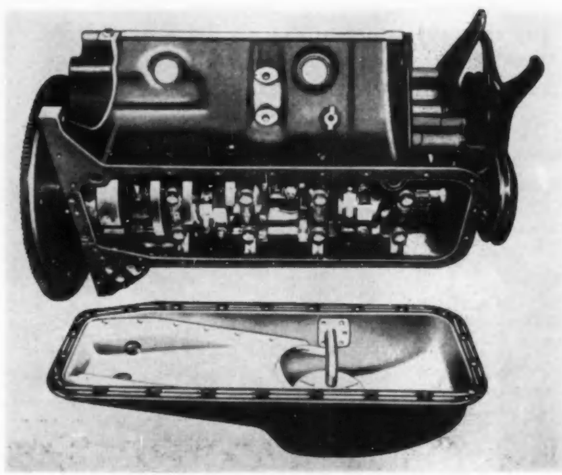
CASTING OF THE NEW CYLINDER BLOCK is made much easier because of the overhead valve construction. The number of cores required has been reduced from 29 for the 1953 V-8 (left) to 14 for the 1954 V-8 (right). This also makes the block more compact and simplifies its construction.



INTAKE MANIFOLD incorporates over-and-under passages, permitting largest possible port areas within the space dictated by the engine length. Risers for the duplex carburetor are connected independently to longitudinal passages feeding lower ports at one end and upper ports at the other end. The branches meet these longitudinal passages at right angles, so that the fuel-air mixture is divided equally to both sides. Contours of the passages are smooth and equal in cross-section area throughout. Generous radii are provided at all junctions.



A DEEP-SKIRTED CRANKCASE provides additional support for the five-bearing crankshaft in the new engine. Note that the engine has a 240-deg main bearing support instead of the old 180-deg support.

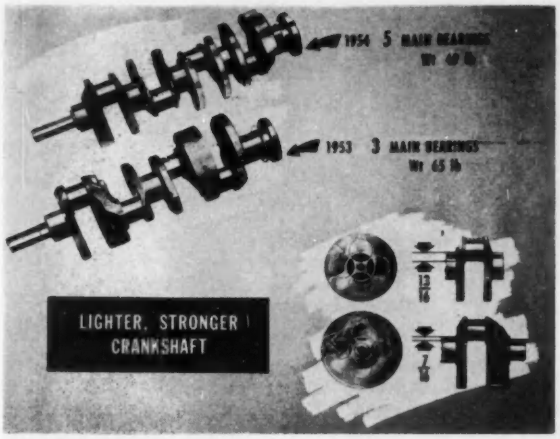


SHALLOW, MORE RIGID OIL PAN with a continuous sealing flange, is an extra dividend provided by the deep-skirt crankcase. The sealing flange is one inch wide and has parallel beads stamped into its surface.

This construction makes it unnecessary to provide additional reinforcement. Beads are so located that they form stiff sealing bridges between the bolt holes.

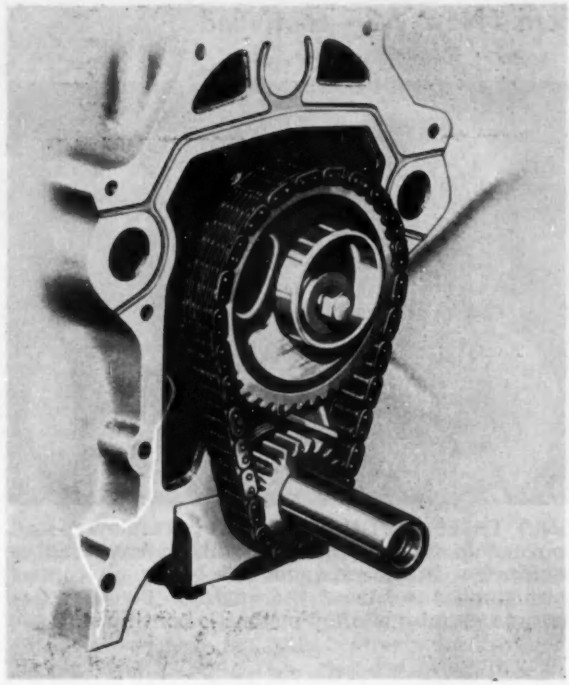
The sump is located at the front of the engine because of the location of a cross-member in the front suspension. The round-nose sump deflects stones better than a rectangular-shaped one.

An antisurge baffle is incorporated in the oil pan, which is designed to supply oil to the externally mounted pump on grades as steep as 30%. The drain plug is located at the rear of the sump.

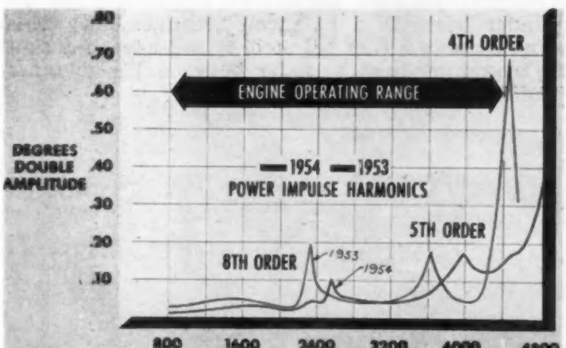


CRANKSHAFT has five main bearings instead of three, as formerly, and is precision-molded of alloy iron. The very short stroke in this new engine (3.10 in.) results in a crankshaft having a large amount of journal overlap—nearly 13/16 of an inch. This contributes greatly to the lightness and rigidity of the new shaft, which is actually 16 lb lighter than its L-head counterpart.

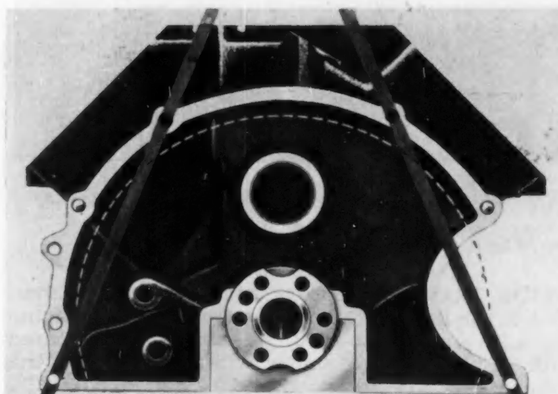
Connecting rod journals are 2-3/16 in. in diameter. Bearings have a total effective area of 39.08 sq in. The main bearing journals are 2½ in. in diameter, and the total effective area is 28.28 sq in. End thrust is taken on a flanged center main bearing. Steel-backed micro-babbitt is used for both main and connecting-rod bearings.



CAMSHAFT is driven by a one-inch silent chain, having a three-eighths pitch. Deflections are held to a minimum by the short center distances between sprockets. The camshaft sprocket is hardened cast iron, and the crankshaft sprocket is alloy steel, case-hardened.



STIFFNESS OF THE NEW SHAFT is shown by this graph of torsional vibration. Harmonic peaks are not only lower in amplitude, but they occur at higher engine speeds, fourth-order vibration being well outside the engine operating range. For these reasons, it was unnecessary to include a torsional vibration damper on the new engine, in spite of its greater output.



WIDE-BASE BELL HOUSING connection minimizes tendency to sag, assuring good alignment of the crankshaft with the drive line.

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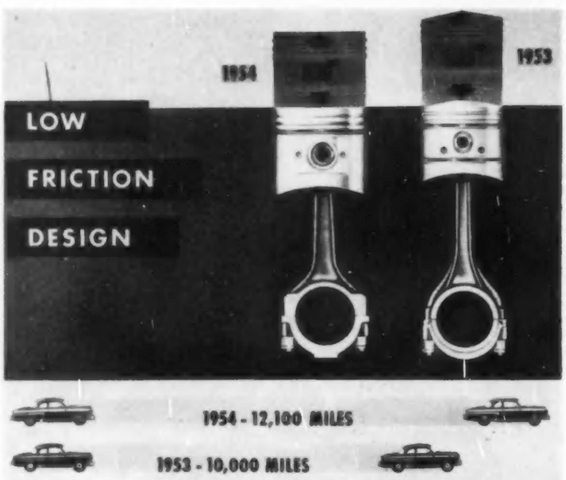
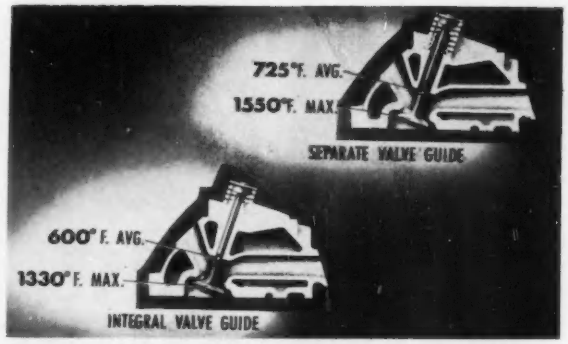
ONLY THREE PISTON RINGS are employed — all above the piston pin. The oil control ring is equipped with an expander for better oil control throughout the life of the engine. Use of autothermic aluminum alloy pistons is continued.



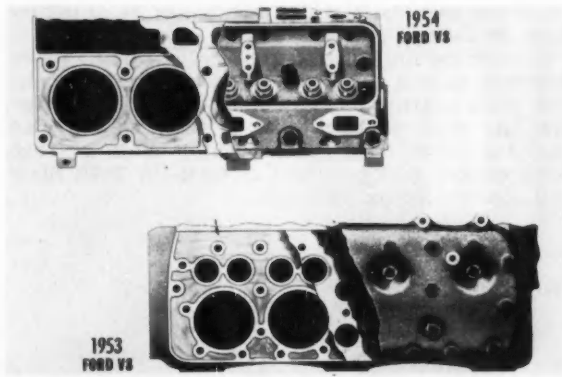
PISTON TRAVEL is approximately 17% lower than that of the 1953 V-8. That's because the new engine has a 3.5-in. bore and a 3.1-in. stroke, as compared with a 3.19-in. bore and a 3.75-in. stroke, in the L-head V-8.

Since the new engine has approximately the same displacement and compression ratio, this low-friction design is believed to be the greatest factor contributing to the higher power output of the 1954 Ford V-8.

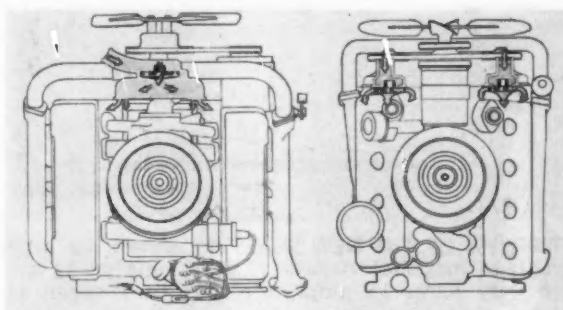
All other things being equal, the larger bore also permits use of valves with head areas 36% larger, providing obvious breathing advantages.



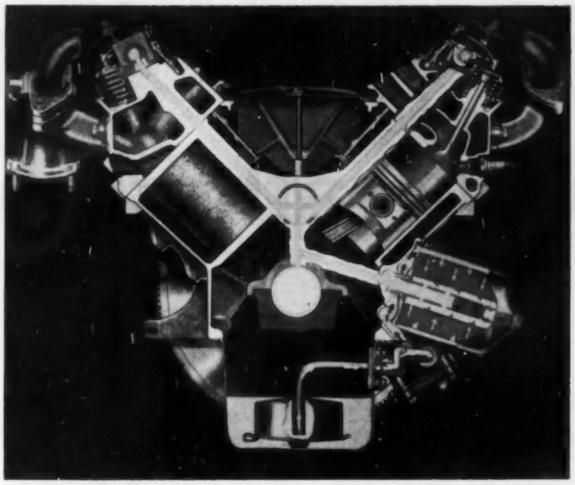
INTEGRAL VALVE GUIDES make it possible to reduce average stem temperatures from 725 to 600 deg, and maximum valve-head temperatures from 1550 to 1330 deg. With integral guides, there is only a clearance and one wall between the valve stem and the coolant, whereas with separate guides, heat must penetrate twice as many insulating barriers.



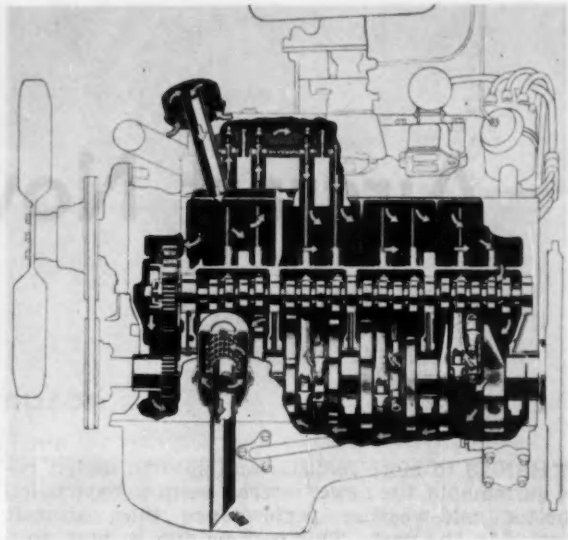
DEEPER CROSS-SECTION CYLINDER HEAD permits a reduction in the number of hold-down bolts from 24 to 10. The bolts are located closely around the cylinder bores in a balanced arrangement. This permits use of a thin, all-steel cylinder-head gasket for maximum heat transfer between the cylinder head and block.



ONE PUMP instead of two is used in the cooling system. This single, high-capacity pump discharges directly into an equalizing chamber from which a balanced flow is fed to both cylinder banks.

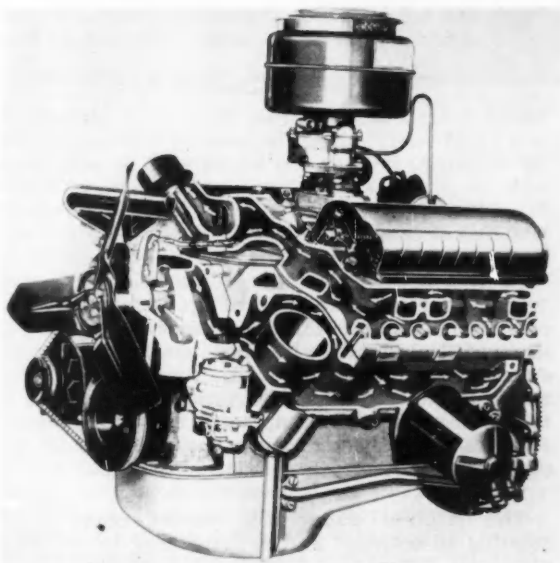


FULL-PRESSURE LUBRICATION is provided. Oil is picked up from the 4-qt sump through a fixed screened inlet and transferred to the externally mounted gear-type pump. The oil is pumped through a short, drilled passage in the cylinder block directly to the full-flow oil filter. It leaves the filter through the hollow center bolt and is fed to the main oil gallery, which runs the full length of the cylinder block. Main and camshaft bearings are lubricated directly from this gallery. Connecting rod bearings are lubricated by full pressure, through the crankshaft.

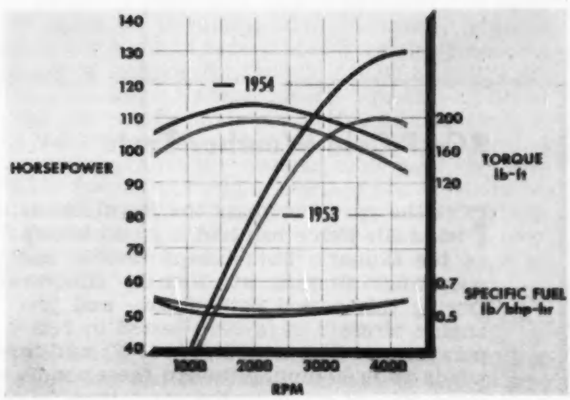


CONSTANT-FLOW VENTILATION is used. By careful design, it was possible to achieve an air flow of from 1 to 4 cfm over the entire speed range.

Fan-driven air enters at the top of the engine through an oil-wetted filter. After ventilating the rocker covers, the air is carried downward into the crankcase, where it picks up corrosive blowby gases and is immediately discharged through a screened road draft tube. The outlet is baffled and has a drain-back tube to prevent oil pull-over.



COOLING SYSTEM in the new engine is similar to that of the previous engine in that the series-flow principle is employed.



PERFORMANCE comparison between the old and new V-8 engines shown above is all the more significant because the two engines have the same compression ratio and displacement.

Whereas the L-head V-8 developed a maximum of 110 hp and 196 lb-ft torque, the new engine develops 130 hp and a maximum torque of 214 lb-ft.

Specific fuel is also lower in the new engine over the entire speed range.

Aircraft Now Weathering

THANKS to more realistic and specific design requirements, the newer aircraft seem to have much better cold-weather performance than aircraft tested in the past. This may be due, in part, to a global outlook that requires aircraft to operate in all parts of the world, including the ice caps. Another factor tending to force designers to design for low temperatures is that jet aircraft are more economical at high altitudes, at which the temperatures are always low, no matter what the latitude.

Some of the improvements have been due quite directly to the testing done at cold-weather facilities of the United States and of Canada. Thus, it seems worth while to describe a few of the experiences of the RCAF at its Namao cold-weather testing facility.

Airframe Lubrication

Airframe lubrication was at one time a great problem. Control systems became so stiff that it was almost impossible to move them; wheels stiffened so much that aircraft were actually taxied on the snow with the wheels locked. The use of such greases as MIL-G-3278 and oils such as MIL-O-6085a have reduced these problems to negligible proportions. MIL-G-3278 has been used in cold temperatures in high-pressure applications, such as wheel bearings, with satisfactory results, and no evidence of excessive wear.

Differential Contraction

Differential contraction has resulted in skin buckling, in loss of tension in cables, and in cracking of perspex and other plastic panels in the airframe. No really serious cases of buckling have occurred in the detachment's experience but skin wrinkles have appeared disconcertingly, especially near heated ducts. Loss of tension in the control cables has been serious on some aircraft. Tensions have dropped from 100 lb to less than 30 on some

RCAF Cold-Weather Tests

FOR the past five years the Royal Canadian Air Force has had a group known as the Climatic Detachment testing and operating aircraft at Namao, Alberta. During this period both piston- and jet-engine aircraft have been tested in temperatures as low as –52 C (–61 F) and in winds up to 60 mph, although these conditions did not occur at the same time.

In general, this experience has shown, according to the author, that aircraft can be maintained, serviced, and flown in such weather conditions. Some engines can be started and run without external aids or heat at temperatures down to –47 C (–53 F), while others require only moderate amounts of heat if it is applied in the right place.

Presented here is the part of the author's paper that discusses cold-weather problems associated with airframe lubrication, differential contraction, hydraulic, pneumatic, and electrical systems, instruments, telecommunications equipment, servicing, removal of ice and snow from the airplane, clothing for personnel, and actual flying.

The original paper also covers cold starting of both jet and reciprocating engines, oil systems, and propeller controls.

Arctic Better

S/L C. R. Thompson

RCAF Central Experimental and Proving Establishment, Climatic Department, Edmonton, Alberta

Excerpts from paper "Cold-Weather Operation of Aircraft" presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1953.

control cables and from 25 lb to complete loss of tension on trim control cables. It was common practice on one aircraft for the crewman to go down the fuselage just prior to take-off to ensure that the elevator trim tab control cable had not slipped off its pulleys. The use of deeper pulleys, the provision of carefully designed fairleads, and in some cases, the use of spring tensioners has reduced this problem to the point where it is no longer serious.

Perspex panels and canopies are very prone to cracking in low temperatures unless they are properly formed and properly annealed after forming to remove residual stresses, and provided the holes used for attaching them to the airframe are elongated to allow for slight relative movement.

Hydraulic System

Hydraulic leaks still persist as a serious cold-weather problem on some aircraft. These leaks are usually due to differential contraction at unions or hardening of sealing glands or wearing of the glands due to small patches of ice on the jacks.

During the past three years the Detachment has tested several aircraft fitted with liquid-spring oleos. These oleos are completely filled with hydraulic fluid with no air space. This type of leg has been very free of hydraulic leaks caused by low temperatures probably, partly because the high pressures to which they are precharged compressed the sealing gland rings and increased their effectiveness. These pressures are usually from 3000 to 5000 psi. However, due to differential contraction between the liquid and the metal of the piston and cylinder, the minimum permissible strut extensions have been violated in almost every case, in temperatures below − 30 C (− 22 F). This has led to the technique of exposing the aircraft to low temperatures and then jacking the aircraft in the open and precharging the leg to the pressure specified for normal temperatures. This has led to pressures of the order of 10,000 psi when the oleo warmed up and has necessitated bleeding the leg and recharging as the weather warmed up again. Consideration has been given to tolerating lower than specified minimum extensions but bottoming after a fairly hard landing has shown that the limits specified are reasonable.

Pneumatic System

Some of the British aircraft tested have used pneumatic pressure for many services in addition to brakes. In some aircraft the flaps, speed brakes, and even undercarriage raising and lowering have been operated pneumatically. Formerly, a great deal of trouble was experienced with these systems because of freezing condensate. Now, a small container—usually of about 150-cc capacity—is fitted in the pneumatic system and filled with alcohol. The intake air passes over this and carries alcohol vapors throughout the system. This vapor is sufficient to lower the freezing point of any condensate. Since these anti-icing devices have been fitted, icing troubles in pneumatic systems have been negligible. Consumption of the alcohols has been of the order of 150 cc for each 10 hr of flying.

Electrical System

The electrical system is affected in cold weather by stiffening and cracking of insulation and plastic covers, stiffening of switches, solenoids, relays, and actuators. Motors burn out due to the extra loads imposed and the lack of back emf because of turning more slowly in the cold unless very carefully protected by circuit breakers. The deterioration of battery capacity in cold weather is also a problem. The Detachment has tested alkaline batteries in the hope that they would give better performance in the cold, but lead-acid batteries proved far superior to alkaline batteries in capacity and reliability; they were much lighter for a given capacity

and the evaporation rate of the electrolyte was much less.

One of the major electrical problems still to be solved at the moment is the high rate of brush wear experienced at high altitudes. The wear is thought to be due to one or more of the following:

(a) Lack of moisture, that is, lubricant for the brush.

(b) Low temperature.

(c) Decreased air density.

(d) Highly ionized air.

(e) Other causes as yet unknown.

Testing in cold weather at low altitudes has shown that the first two have not been a major cause of wear.

Instruments

One of the more common instrument troubles experienced has been the failure of pressure gages to register. This has usually been due to the use of too heavy a transmitting fluid and too long a transmitting line. The problem has been overcome by shortening the transmitter lines, positioning the transmitter below the tapping, and priming the line with a light fluid such as varsol.

Magnetic compasses have frequently become unservicable due to the formation of bubbles. These are sometimes due to the formation of a partial vacuum caused by differential contraction but are normally due to small leaks. Sealing compounds, which have been tested during the past two years under very severe cold and hot conditions, have allowed no leaks, and show promise of curing the leakage problem.

Air-driven gyro instruments are unreliable below -20 C (-4 F). Aircraft fitted with them require efficient cockpit heating before take-off if these instruments are to be depended upon. Erection times at -40 C (-40 F) may be as long as 20 min. Electrically driven gyro instruments have proved much more reliable.

Aircraft clocks are unreliable in cold weather and most of them stop if their temperature is below -30 C (-22 F). A set of clocks lubricated with silicone oil operated within limits at temperatures down to -45 C (-49 F), so that the solution to this problem may have been obtained.

Telecommunications Equipment

The main cold-weather troubles experienced in the past few years have been with band-change mechanisms, which become stiff if lubricated heavily; stiffening of shock mounts, with consequent failures of tubes; and whip aerials and wick dischargers have failed due to brittleness.

One major radio trouble that the Detachment is anxious to solve is precipitation static. This is not confined to low temperatures but frequently in arctic weather fine ice crystal haze covers a large area. The ice particles are charged and consequently charge the aircraft flying through them both by induction and friction. The static resulting from electrical discharges from various points causes interference, which makes the radio signals unreadable and the radio compass unreliable. This static affects the lower range frequencies, which must be used more frequently in the north due to the great distances between airports. Some protection is afforded by the use of polyethylene-covered aerial wires. Various attempts have been, and are being, tried to charge the aircraft with positive polarity and thus reduce the discharge or to control its frequency. These experiments are still continuing.

Servicing

The Detachment has shown that servicing of aircraft can be done in temperatures down to -50 C (-58 F). Engines have been changed, starters and other accessories have been removed and replaced, skin repairs have been done, wheels changed, and so on. On the average, from 50% to 100% more time is required for routine maintenance than is necessary at normal temperatures. A little heat from a ground heater—and a shelter from the wind—even a tarpaulin or a sheet of plywood or metal—makes a great difference to the comfort and, consequently, the morale and efficiency of the maintenance technician.

Refueling aircraft presents few problems in cold weather except that extra care must be taken not to spill the fuel over any exposed flesh, since the added cooling caused by its evaporating will speed up freezing of the exposed portions. Dermatitis, especially with kerosene-based fuels, is more prevalent in cold weather, due to chapping and roughness of the skin. Since the explosive range of saturated fuel vapor, such as occurs in partially filled fuel tanks, is between -10 C (-14 F), and -40 C (-40 F), extreme care must be taken to ensure proper grounding is made before refueling. The Detachment experienced one serious explosion during refueling. Just before refueling, an airman had swept snow off the wing of the aircraft and had apparently become highly charged with static electricity. The explosion occurred when he took off his glove and touched the refueling nozzle. A spark was caused, which initiated the explosion.

Re-oiling is more of a problem in cold weather, especially for large aircraft. Oil barrels in caches in the north must first be warmed so that the oil will flow. Pumping the warmed oil is difficult because the oil cools very rapidly in the hose in cold weather and congeals so thoroughly that it is soon impossible to force any oil through the hose. The Detachment favors the supply of oil in 5-gal containers, which are easy to man-handle, quicker to heat, and simpler to stow. It is advisable to re-oil before dilution on shutdown or after warmup following engine starting, to avoid forcing undiluted oil into the lines.

Removal and replacement of batteries is a chore in cold weather. The access is usually awkward to a person wearing winter gear, the cables are stiff, the drain tubes are brittle, and the batteries are heavy. Quick disconnect, pull-out tray installations are heavily favored.

Removal of Ice and Snow

The Detachment has found no really successful method of preventing and/or removing ice, frost,

and snow from aircraft except the use of a heated shelter. Covers are useful for loose snow, but slushy snow and freezing rain cause the covers to freeze to the surface they are supposed to protect and make them exceedingly difficult to remove. The really cold weather experienced in the Canadian subarctic during the winter is usually associated with clear skies and heat radiation, so that temperatures dip quickly overnight, with the resultant high relative humidity and formation of hoar frost. This can usually be brushed off but it will form even under aircraft covers.

Snow, especially dry snow, can be brushed off but ice and wet snow, which have subsequently frozen onto aircraft surfaces, are most difficult to remove. Various alcohols, glycols, and other fluids have been tried but most of them are very expensive and are ineffective below −25 C (−13 F). Heat from portable heaters has been used but, while this has melted the ice, the water has then run to a lower part of the aircraft surface and refroze. On one occasion the ice on one jet aircraft was removed by parking it in the jet exhaust stream of another. This was very quick and effective but was considerably more expensive than the use of just an ordinary ground heater.

The airframe problems associated with slushy snow and freezing rain during the transition temperatures close to 0 C (32 F) are as vexing as those experienced at much lower temperatures. Slushy snow entering parts of an aircraft and then freezing either overnight or during flight can cause such awkward incidents as frozen brakes, undercarriage frozen up or down, flaps frozen up, and plugged vent lines. For instance, last winter one vent line became plugged with slushy snow just prior to takeoff and caused, by a curious series of coincidences, a fire in the aircraft in the air.

The aircraft cover material which has given the best service at the Detachment and which has been the easiest to handle has been vinyl-coated nylon. The fasteners must be large and easy to fasten so that a person wearing large mitts can do them up easily. The covers must be clearly marked with identification points, preferably using various colors, so they can be laid on the aircraft quickly and accurately for operational requirements. The method of fastening the covers must be such that they can be removed in a matter of seconds. All openings on the aircraft must be protected by covers or fitted with blanks or plugs to prevent the entry of snow.

Covers are most useful in falling or blowing snow, but at the Detachment if clear weather is forecast, only engine blanks and plugs for the open holes in the airframe are normally fitted.

One major trouble in cold weather is keeping the windscreens clear. The Detachment would like to see all windscreens at least double-paned with dry air between the panes or, better, they would like to see them be triple-paned with one dry air space and one heated air space.

It has been common practice at the Detachment to provide the pilots with a small plastic scraper with which to remove the frost that forms on the inside of windscreens when cockpit and windscreen heaters are inadequate or when they fail. On several occasions the pilots have landed the aircraft by peeking through a small 2 × 2-in. clear space hastily cleared on the windscreen.

Clothing for Personnel

To educate the aircrew and passengers to wear clothing in which they would have a better chance of survival if an emergency arose, the Detachment advocates restricting the cockpit and cabin temperatures in its aircraft to between 5 C (41 F) and 0 C (32 F). To enable the navigator to work in such temperatures, heated navigator's table tops have been developed which keep his hands warm for plotting and log keeping but allow him to remain cool enough so that he is not uncomfortable in his winter flying kit. A table from which it was possible to select heaters that gave a power dissipation through the table of 55 or 75 w per sq ft has proved acceptable. On one occasion a 5-hr flight was made at outside temperatures of −40 C (−40 F) during which the heaters on the aircraft failed and the temperature in the cockpit dropped to −25 C (−13 F). Under these circumstances the navigator's heated table top was a particular asset.

Clothing for servicing aircraft in cold weather must be warm, light, not too bulky, the cloth must be snag-proof, moisture-resistant, and oil repellant. There should be an adequate vapor barrier to prevent freezing of body vapor but at the same time there should be provision for absorption of sweat. The clothing should be layered, so that when the technician goes into a heated shelter, or as temperatures warm up, outer layers may be removed to prevent excessive sweat. Pockets should be large, accessible, and have flaps that will exclude snow and yet can be handled with mitted hands. The waist should gather to prevent draftiness inside the clothing and excessive loss of heat. Gloves should be provided with an inner light, anti-contact glove, a woolen or leather glove for warmth, and an outside mitt. Mukluks with inner duffles and plenty of socks are the recommended footwear. An outer windproof parka with skirt length almost to the knees and a close-fitting wolverine-fur-trimmed hood completes the desirable cold-weather costume.

Flying Problems

Extremely cold temperatures in the north are caused by surface radiation, and are usually associated with a high-pressure system, with clear skies. Usually, a temperature inversion exists. In extreme conditions it is not unusual to find the temperature on the ground −40 C and the temperature at 8000 ft as high as 0 C. The relative humidity is usually very close to 100%. Thus, the disturbance of the air by running aircraft engines, together with the moisture added to the air by the engine exhaust, has caused ground fogs. These fogs were so thick and persistent that, although it was perfectly clear just prior to take-off, once the aircraft had become airborne it could not land because of the fog. In some cases this fog has persisted for hours. In northern areas where airports are 300 to 500 miles apart, this is a serious problem indeed, especially when a large number of aircraft must be operated.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Experts Tell...

How to Cut those

PRODUCTION men plagued with production tooling and metal-working problems found their pilgrimage to the 1953 SAE Toronto Production Forum a highly profitable one. There, among other things, they learned that:

- Premature failure of carbide-tool chip breakers is the result of their being too narrow, too deep, or too rounded in the back corner.
- Clamping carbide tips to tool shanks—instead of brazing them on—is the trend today.
- From the standpoint of tool life, no finish is too good for a carbide tool.
- Crystallography studies of metals can reveal easier ways to machine them.
- Refrigeration of cutting oils should be considered.
- The question of when to replace machine tools can be figured out by a mathematical formula.

Chip-Breaker Shapes Bear Watching

Shape and dimensions of carbide-tool chip breakers are all-important. Ground chip breakers that are too narrow, too deep, or too rounded in the back corner may fail to work properly after machining only two or three pieces.

Best basic size is 0.010 in. deep by 0.100 in. wide. For best efficiency, a chip breaker should be made as shallow as possible. The back corner should be fairly sharp, not rounded. The back of the groove should never be deeper than the cutting edge. A 2 deg negative rake avoids any chance of this. (It also shifts the heaviest cutting pressure farther back on the tool.)

Certain alloys just won't respond to chip breakers. The thing to do in such cases is to grind the tool so that it gives tight-curling chips that don't endanger the operator.

In experimenting with an alloy new to a shop, experiments should start with the basic 0.010×0.100 and go in the direction of decreasing width. Never increase the depth.

Mechanically held (clamped-on) chip breakers have one serious fault. They allow chips to work between the breaker and the top of the tool.

Harder materials usually require that the chip breaker be placed farther back than softer materials.

Carbide Tips Held on by Clamps

The swing is away from brazing carbide tips to tool shanks. Instead, more and more are being clamped on. Reason for this is that breakage is less serious and costly when tips are clamped on. For that matter, slender tools crack more readily when brazing is employed. Clamping is the answer here.

What's more, since brazing tends to check the harder carbides, it is possible to use a slightly harder grade of carbide in a clamped tip.

No Carbide-Tool Finish Is Too Good

Tool failures begin at scratches or pits. Thus, better tool finishes will give longer tool life. To illustrate, one company found that diamond-honed tools lasted four times as long as machine-ground tools.

In short, super-finishing, using 400-grit diamonds, is recommended. It is also a good idea to break off the tool edge (0.001 in. at 45 deg) with a hand hone. Carbide toolmakers don't do this when tools are shipped, since few tools go right into service without some modification.

Crystallography Has a Lot to Offer

Crystallography studies can help the metallurgist explain a lot about the vagaries of metal cutting.

For example, studies have shown that when deformation takes place along the axis of a crystal, the crystal will slide until it meets another crystal. Thus, it may be possible by proper heat treatment to arrange crystallized structure so that it either aids or interferes with slip.

Crystallography studies also can explain why metals machine easier when they are hot machined. When metal is heated, the interatomic space increases and cohesive force is reduced. Thus it takes less work to separate crystals from one another.

(Hot machining experiments have been carried on using induction coils which precede the cutting tool and heat the metal to a depth very little deeper than that of the cut. In this way distortion is prevented, since the main body of the metal is not affected by the heat. Virtually all of the heat goes into the chip.)

Keep Cutting Oil Cool

Refrigeration of cutting oils should be considered. In hot weather, coolant temperature can build up

Metal–Working Blues

R. E. Crawford, Editor, Canadian Machinery and Manufacturing News

Based on secretary's report of Panel on Production Tooling and Shop Methods held as part of the 1953 SAE International Production Forum, Toronto, Oct. 29, 1953.

anywhere from 120 to 180 F. This, in turn, causes gaging to be thrown off on certain jobs. For example, simultaneous turning and boring of thin tubular shapes.

Water is frequently used to cool cutting oils. But whatever the method of cooling, the important thing is not to overdo it. Otherwise the oil will become too viscous. It's important to hold the temperature for which the oil is designed (usually 100 F).

Formula Tells When to Replace Tools

When should a machine be replaced?

The National Machine Tool Builders' Association suggests retiring a machine when it has paid itself off at a rate determined in terms of a percentage of the invested capital. Against this plan, however, is the question of how to determine the correct percentage to use.

The Machinery and Allied Products Institute, on the other hand, offers a mathematical formula. Developed by machine-tool builders and users, this formula permits detailed comparison of the various factors which should be considered between the proposed machine, the "challenger," and the existing machine, the "defender." (Some 31 items, including capital cost, interest accumulation, obsolescence rate, salvage value, and repair costs are taken into consideration).

These calculations show the cost of keeping the old machine in operation as compared to buying a new machine.

Principal drawback with this approach is that the formula is felt to be too complex. It requires a good deal of training to use it. Something simpler is usually needed.

(The report on which this article is based is available in multilithographed form, together with reports of the seven other panels of the 1953 SAE International Production Forum. This publication, SP-305, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Ways for Chasing Metal-Working Blues . . .

. . . outlined in this article were volunteered by this panel of production experts:

Edgar Barker, Panel Leader
President, Modern Tool Works Ltd.

R. E. Crawford, Panel Secretary
Editor, Canadian Machinery and Manufacturing News

Sinclair Wilson
Carbide Tool Application, Field Engineer
A. C. Wickman (Canada) Ltd.

F. G. Harris
Field Abrasives Application Engineer
Norton Co. of Canada Ltd.

R. Stewart
Chief Metallurgist, Pratt and Whitney Division
The John Bertram and Sons Co. Ltd.

C. P. Farr
Chief Engineer, Modern Tool Works Ltd.

R. Schablitzke
Manager, Industrial Sales
McColl-Frontenac Oil Co. Ltd.

J. Harrison
Assistant Master Mechanic,
McKinnon Industries Ltd.

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Colonial Tool Co. Ltd.

J. Dowler
General Superintendent, Industrial Engineering Division
Ford Motor Co. of Canada Ltd.

E. Bartle
Assistant Master Mechanic, Gas Turbine Division
A. V. Roe (Canada) Ltd.

Experiences Pooled on . . . Five

ONE manufacturer's success in fabricating an aluminum impeller using a standard Keller with a specially designed attachment . . . . Reports by several producers of experiences bearing on the controversial question of helical carbide cutters . . . . Similar pooling of experiences on how best to machine integrally stiffened skins and high test tensile steels . . . . and a general agreement that it's hard to share experiences about machining titanium because no two companies seem to be getting the same material . . . . These are the areas from which facts are reported on the pages which follow.

One Way to Machine an Impeller

Following are the steps of three-dimensional machining necessary to develop the finished work piece from bar stock, using a standard Keller with a specially designed attachment.

Following rough and semi-finish machining, the impeller was tested at 72,000 rpm, some 20,000 rpm faster than intended working conditions. This served not only to uncover flaws in the basic material, but also to "stretch" the metal preparatory to the finish machining.

Then the blades were hogged out with a helix spiral operation which left "islands" of surplus material on the work piece. Next the blades were backed with a low melting point eutectic alloy. Finally, the wheel was statically and dynamically balanced with hand polishing.

This method of fabrication is said to make possible machining to within plus or minus 0.001 in. on the O. D., with blade contour held to within 0.005 in.

This same method has proved successful for machining Inconel "X" and other high temperature alloys used for turbine rotors and exducers. Only a single pass is necessary for the actual machining, although hand finishing still must follow. For parts made of these "super" alloys, forging methods are said to be practical, with even castings being satisfactory in a number of cases.

Machining Panel Members . . .

J. S. Logan, leader
Solar Aircraft Co.

J. R. Howard, coleader
Rohr Aircraft Corp.

H. W. Ingalls, secretary
Solar Aircraft Co.

Frank Eppick
Consolidated Vultee Aircraft Corp.

C. J. Harman
AiResearch Manufacturing Co.

R. B. Scott
Lockheed Aircraft Corp.

F. M. Rayburn
Menasco Manufacturing Co.

Machining Problems

H. W. Ingalls, Solar Aircraft Co.

Excerpts from secretary's report of Panel on Machining held as part of the SAE Production Forum at the SAE National Aeronautic Meeting, Los Angeles, Sept. 30, 1953.

Cutter Design

One major airframe company reported excellent results using two-blade end mills on steels and other ferrous alloys. Although the two-blade tool could not take advantage of the overlap made possible by four-blade tooling, it was indicated that the greater number of cutting blades offer no advantage at present machine speeds obtainable.

On aluminum, one job which formerly took 3 hr had been reduced to 19 min by using 2-in. end mills with helical carbide cutters to make a plunge cut one inch deep at 22 in. per min. A 40 rms finish was obtained.

Another company reported excellent results on 180,000 to 200,000 psi steels, using a positive rake on both end mills and slab cutters. In several applications where a negative rake was called for, the operators found they could get the desired finish by inserting a small positive rake auxiliary blade to follow the initial cutting operation on the same pass.

Neither sidewise vibration nor bearing end thrust was experienced, and chip disposal was satisfactory.

Using all grades of carbides, several companies reported experimental projects on twisting and brazing the cutting blades. All production blades now are sintered to a straight shape, then twisted to the proper camber usually through induction heating methods. But experimentally, the blades have been die formed in the furnace as part of the sintering operation.

In one foundry operation, Kirksite dies had to be hand finished following pouring. A helical carbide tool was developed with a controlled cut of 0.010 in. which completed the finishing operation in less than half the time formerly required. In effect, this tool acted as an oversize burring tool.

Machining Integrally Stiffened Skins

Although there are many problems not yet solved, methods of machining massive aluminum skin sections are improving steadily. By 1956 procedures should be optimum, unless advanced methods of forging are developed to eliminate the necessity of machining such parts from plate.

Warping is experienced in all such parts and is corrected by stretch leveling, shot peening, and the combination of a press brake, two-by-fours, and operator know-how.

Present tolerances are plus or minus 0.010 in., an unsatisfactory figure. Airframe manufacturers want to go to plus or minus 0.005 in., or even to a total of 0.005 in., but present machines will not do the job. A major problem is chip disposal, and a number of ingenious methods have been devised including a follow-up broom, air blasts, and suction tubes.

Despite vacuum hold-downs, chips may get under the work piece and distort it so too heavy a cut will be taken.

Using profilers, tape control mechanism, and other control means, one airframe manufacturer is successfully machining the massive panels. His original schedule called for all machining to be done on the skin mill in one operation. But he has gotten

better results by setting up a second operation to "cut lace," including inspection panel holes, and other necessary apertures. The one-piece construction is considered easier to repair than former assembly constructions, since splicing or addition of patches and doublers are possible.

Although setup time is excessive at present, advancements are being made, and within the next several years, actual machining time should be a major portion of the overall time element.

A discussion of Gantry versus planer type machines indicated that the latter are superior in that far less floor space is required and necessary motive force is lessened.

Control of distortion in big aluminum sections—whether forgings, castings, or machined—is a problem on which much work remains to be done. As one participant put it, "It's just a big wrestling problem. The part will distort under its own weight while being jigged up or removed from a machine."

Distortion due to tool action has been controlled in part by machining both sides of a part simultaneously and balancing the tool pressures. However, this method has only limited application. Another suggestion was that machining might be accomplished with the work piece in the annealed condition if slow speeds were used, although at high speeds, the material should be tempered, then machined.

Machining High Tensile Steels

Weight saving and safety factors are causing increased investigation of steels in the 280,000-psi class for such items as aircraft landing gear, and machining problems will continue to mount until necessary advances are made.

The experiences of one successful sub-contractor in machining these high tensile steels indicate:

By careful control of furnace atmospheres and temperatures, the most successful machining practice is to complete all rough operations with the work piece in the annealed state, then go through an intermediate heat treatment, bringing the material to 170,000 to 190,000 psi and complete all possible machining. Follow with the final heat treat to bring the material to desired psi and complete remaining machining. The final machining should include only finish cut on high finish surfaces, and tapping of threaded holes which should be drilled in earlier stages.

Both carbide and high speed tooling can be used to advantage, and chrome flashing of the carbide bits has led to increased efficiency, due probably to the lubricity provided by the flashing.

Tool life is only a third that of tools cutting standard materials, and this fact must be accepted as nothing indicates developments which would extend the life of the tool.

In high tensile machining, the optimum carbide grade for tools has not yet been found. Density, grain structure, and hardness are the criteria, and frequently one will be sacrificed for the others. However, grades are improving steadily and several experimental samples have given extremely good service.

A coolant is necessary in all machining operations, with the standard soluble coolants found most satisfactory. Carbon dioxide is not satisfactory in most cases. While it cools satisfactorily, it has no lubricity. One gear manufacturer reported excellent results with CO_2.

Using high speed tooling, speeds of 20 to 25 surface ft per min seem best, while the use of carbide tools allows an increase up to 75 surface ft. One airframe manufacturer reported that speeds in excess of 100 ft per min had been used satisfactorily.

Titanium Experiences

Individual experiences in working with titanium make it seem obvious that no two companies are getting the same material.

It has been established that many unsatisfactory operations on titanium sheet and bar can be traced back to the original sponge from which the work piece was developed. Specifications for minimum oxy-nitrogen content of sponge have been developed and are now in effect.

It was agreed that commercially pure titanium can be formed, machined, and welded without too much difficulty. However, the consensus was that this will not be true of the various titanium alloys which are scheduled for small production in the immediate future. In other words, purity increases workability but drastically cuts down strength. Therefore, it was agreed use will be limited to nonstressed structures such as fire walls.

In machining, especially during drilling and tapping operations, the "smear" problem is of considerable proportions. The titanium exhibits a tendency to "grab" the tool and tear or puddle under extreme friction temperatures. Carbide tools with a chromium flash have proven satisfactory to eliminate this problem.

Where sliding friction is encountered between titanium and titanium, or titanium and other metals, at present there seems to be no useful solution. Standard plating seems pretty impossible, although anodic plating is under investigation.

While there is definite shrinkage during welding operations, the amount of shrinking is constant and can be compensated for as is the case with stainless steels of the 18-8 variety.

(The full text of this report, along with that of the secretaries' reports of the nine other panels at this Production Forum is available from SAE Special Publications Department, as SP-304. Price: $2.00 to members, $4.00 to nonmembers.)

Passenger Car Meeting Gives New Answers to Old Problems

PROBLEMS subdued in the 1920's and 1930's are popping up all over again due to the more severe conditions today's automobiles impose, it was brought out at the SAE National Passenger Car, Body, and Materials Meeting, held March 2-4 in Detroit.

Valve train components are showing distress after operation in the new engines with new lubricants. Fine cracks appeared in automotive finishes applied over last year's tin-free solder. And requirements for increased car stability are once more facing tire and chassis engineers.

During the course of the three-day Meeting, close to 1000 engineers entered the Grand Ballroom of the Statler to exchange ideas on these problems and to discuss metal processing, car shake, and British and Continental cars as well. Not even the last and worst blizzard of the Detroit winter kept SAE members and their guests from enthusiastic participation in the eight technical sessions and enjoyment of the dinner ending the Meeting.

Valve Lifters

Valve lifters are again showing scuffing and spalling, the symposium on cam and tappet wear revealed, because the coatings and lubricants that solved earlier difficulties aren't by themselves sufficient to prevent trouble with today's higher-compression engines.

The troubles seem to stem from the fact that when you increase power output for given engine displacement, you require greater valve lift and higher speed to provide increased breathing capacity. You also require stiffer valve springs to insure that the tappet—or lifter—follows the cam.

The result has been that tappets in today's engines tend to wear rapidly in the manner known as "scuffing" and to chip away or "spall."

Two speakers reported that scuffing is worse with low-viscosity oils. A third found no correlation between wear and viscosity. Hardenable cast iron was generally preferred over chilled cast iron or steel as a lifter material.

Cures suggested included: use of certain phosphorous and sulfur compounds as additives in the lubricating oil, improvement in cam finish, reduction in valve spring weight, and avoidance of tappet rotation.

Painting Symposium

The usually efficacious phosphate coatings applied to sheet metal before painting failed to prevent fine-line mapping of finishes during the recent tin shortage, discussion at the painting symposium disclosed. From experience during the 1920's, painting specialists knew that trapped moisture was causing the trouble. They had had the same problem in the days before phosphate coatings when they prepared body parts for painting by washing with alcohol and phosphoric acid. The acid retained in the pores of the solder took up water and led to blistering.

In a similar way, oil in the primer reacted with the lead in the recent tin-free solder and created water-holding soaps. Again mapping developed.

The problem became so common that a variety of fixes emerged. Discussers reported success with each of these: Add 0.5% tin to the solder. Or apply an oil-less first coat (which unfortunately doesn't

adhere so well). Or apply epoxy resins as a wash coat before the primer cures.

Additional discussion brought out that moisture in the form of humidity can be either a help or a hindrance. In the spray booth, moisture in the air favors the flow of lacquer. Practice ranges from 45 to 65% relative humidity at about 80 F to facilitate lacquer flow and help leveling. High humidity in ovens, on the other hand, produces pin holing, so ovens are not kept as humid as they were a few years ago. Water in the bottom of the oven does, however, keep dirt from bouncing, it was noted.

Car Stability

Car stability is again a problem, too, as it was 20 and 30 years ago when tires were more of a mystery than they are now. Underlying a morning of discussion on car stability was the knowledge that modern power steering devices filter out some of the tire responses, leaving the driver without some of the normal assurances of car control. Not only do car builders want to compensate for this, but in cars with or without power steering they want to provide faster responses to steering to match today's higher speeds and to improve steering "feel" at the same time as they make other advances.

Stability involves the subjective evaluation of the driver, engineers were reminded. Main message of the morning was that stability appears to depend on the timing of the various responses that the driver senses. Too long a lag tends to make the car seem unstable. So does too rapid a response.

No one claimed to know exactly how to modify tires to increase stability. But it was generally agreed that inflation pressure, tire deflection, tire size, and probably tread pattern, tread width, tread flatness, cord angle, rubber compound, and rim width influence stability.

The tiny rubber blocks between tread ridges, it was said, improve stability without harming ride. But most other means of improving stability worsen ride characteristics.

In other fields, too, engineers commented on the cyclic nature of their problems. For example, now that extrusion presses are pushing metal along much farther than they ever did before, die designers were reported to have to discard their old strategy in favor of new die shapes and stroke timing. Suspension engineers complained that they no sooner get rid of car shake from one source than it develops from another source in the next model.

Two papers on British and Continental cars left the impression that, while European engineers have their recurring problems, they are encountered and solved at a slower rate. To illustrate how decidedly out of phase the two sides of the Atlantic can get: Although the American trend is definitely toward V engines, a review of contemporary British engines mentioned not a single V type.

All 22 papers presented at the meeting are available in preprint form. Later issues of SAE Journal will carry an abridgment of each paper plus an abridgment of the discussion of it.

Following are one or two significant statements selected from each of the papers:

Following are one or two significant statements selected from each of the papers:

Cam and Tappet Wear

Wear of piston rings and valve lifters and spalling of certain valve lifter materials may be significantly greater for oils of low viscosity such as 5W/20 or SAE 10W than for higher viscosity oils such as SAE 20 or SAE 30 oils of similar formulation.

Use of an oil with good anti-wear characteristics for engine break-in does not guard against future valve lifter wear if the engine is operated with an oil having poor anti-wear characteristics . . .

. . . **H. A. Ambrose and J. E. Taylor**, Gulf Research & Development Co., "Wear, Scuffing, and Spalling in Passenger Car Engines."

In several of the new overhead-valve V-8 engines, the valve spring force has been increased to keep the linkages in the flexible overhead-valve mechanism in contact. For better engine breathing the valve size, lift, and cam ramp severity have been increased.

These—and no doubt other—design changes have resulted in increased severity of the lubrication requirement.

Of the many different types of additive materials evaluated, phosphorus and sulfur-phosphorus compounds appear most suitable for use in motor oil to prevent distress of cams and valve lifter faces. What's best for one metal combination may not be best for the others, however . . .

. . . **T. W. Havely, C. A. Phalen, and D. G. Bunnell**, Shell Oil Co., "Influence of Lubricant and Material Variables on Cam and Tappet Surface Distress."

Engine B's design is such that lifters frequently do not rotate. When rotation does not occur, lifters do not pit. There is some wear on the lifter face, and a groove is worn on a diameter. (With this design pitting can occur if the lifter does happen to rotate.)

The least wear in all of the combinations tried occurred in Engine B with alloy iron lifters. Wear was also small in two other engines with the same lifter material . . .

. . . **J. B. Bidwell**, Research Laboratories Division, GMC, and **Paul Vermaire**, Diesel Equipment Division, GMC, "Lifters and Lubricants."

Painting the Passenger Car

Automotive enamels are baking colors based on alkyd and amine resins which dry mostly by heat conversion. Their film-forming ingredients polymerize at about 250 F.

Modern enamels take no longer to bake than do conventional lacquers. They require only 60–70 F hotter temperatures than the lacquers.

Enamels can be adapted readily to electrostatic application . . .

. . . **A. J. Lapointe**, Lincoln-Mercury Division, "Automotive Enamels."

Today when a paint chemist refers to "lacquer," he means a paint which dries simply by the evaporation of the solvents used

Gen. Curtis LeMay Speaks on U.S. Answer to Aggression Threat

Walter E. Jominy, general chairman of the meeting, checks plans for the speeches to follow the dinner with principal speaker Gen. Curtis E. LeMay, USAF; toastmaster Robert L. Biggers; and SAE President William Littlewood

Gen. Curtis E. LeMay, Commander of the Strategic Air Command and the youngest U.S. military man ever to wear four stars, warned in his dinner speech that the Soviets have more than 20,000 aircraft in combat units and more than 1000 long-range bombers capable of reaching targets in this country on one-way flights. Even under conditions most favorable to defense, a sizeable portion of bombers will always get through, he predicted. (Even in Korea where there were 10 Migs for every B-29, we lost less than one B-29 per thousand bomber flights due to fighter action.)

If our air defense measures ward off only 2% of an attacking force, they will be worth while, General LeMay said. But, he continued, a true defense requires both a shield and a sword.

The one significant weakness in Soviet armor is her industrial production, LeMay pointed out. Long-range bombers could destroy the industrial centers and topple the Soviet military giant.

The one measure for determining military requirements, said LeMay, is this: The force or composition of forces must have sufficient strength to prevent war by convincing a potential aggressor that he could not profit by starting a war.

Speaking on transportation safety, SAE President William Littlewood, who is American Airlines' vice-president for engineering, noted the similarities in good packaging of the automobile passenger and the airplane passenger.

Sudden deceleration is the big hazard in both cases, he emphasized, pointing out that as protection against this danger, vehicle engineers should:

- Preserve the container reasonably intact so as not to spill out the contents or damage the "cargo" by excessive distortion of its housing.
- Support the delicate cargo at its strong points.
- Protect passengers from damage by transmitted shock and by violent contact with the inner walls or irregularities or by loose missiles within the container.
- Minimize injury by shock-energy-absorbing provisions in the container design, materials, or arrangement.

Littlewood reminded his audience that in any vehicle crash which one person survives, there are elements which would permit others to survive. He hailed the agencies now collecting data on crashes and near-crashes with a view toward determining what improvements can be made in vehicles.

Around the Meeting . . .

K. E. Coppock and William Littlewood

After being greeted by Detroit Section Chairman **K. E. Coppock** (left), SAE President **William Littlewood** reminisced about landing at the old municipal airport in the shade and air bumps of the gas tank. Now, Littlewood admitted jokingly to the Fisher Body man, he comes to Detroit by car because American Airlines, of which he is a vice-president, and the other airlines land 35 miles away at Willow Run.

Smokestacks of Detroit assembly plants show up so clearly on the radar screen that USAF bomber crews have ceased to use Detroit as a training target, **Gen. Curtis LeMay** revealed in his dinner speech. But they are making practice attacks on other major cities each month.

Crews of the bomber force make a successful hookup with a tanker plane and take on fuel in flight at a predetermined rendezvous on an average of every five minutes, 24 hours a day, 365 days a year. More than 98% of these aerial refueling operations are successful, the general reported.

He characterized the typical bomber commander as a 32-year old, married man who has spent 9 years in the Air Force and accumulated 3500 hours of flying.

"There are only two good ways to finish an automobile—lacquer and liquor," opined an opponent of enamel at the symposium on painting of automotive vehicles.

Tom Scherger of Studebaker told this one about the pilot of a three-stage rocket. Seems he pushed the button to take off on the first stage, then looked back and found that the earth looked like a big sphere.

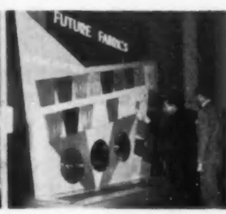
He pushed the second-stage button, looked back toward earth, and saw what appeared to be a basketball.

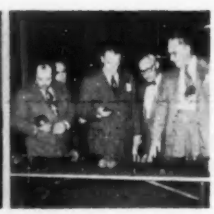
He pushed the third-stage button and looked back on a ping pong ball. "Good God!" he said.

"Yes, my boy?" came the answer.

We ought to be grateful for any insight into the foreign market. Someday we might want to export something out of this country that we got paid for, quipped **Maurice Olley** of Chevrolet.

Bad weather didn't deter SAE'ers interested in fabrics, forgings, and the many other topics of the Meeting.





to apply it. No chemical reaction takes place. (Enamel does require a chemical reaction—like oxidation—to produce a hard film.)

Automotive enamel is based on nitrocellulose, which is basically cotton linters treated with nitric acid.

Lacquer is used on Buick, Cadillac, Chevrolet, Hudson, Oldsmobile, Packard, and Pontiac . . .

. . . **R. J. Wirshing**, General Motors Corp., "Lacquer as a Finish on Automobiles."

Automotive paints are tested for film hardness, thickness, gloss, color, adhesion, brittleness, abrasion resistance, alkali resistance, ability to withstand bending, and many other qualities.

Here's one simple adhesion test: With a razor blade, 11 parallel cuts 1/32 in. apart are made through the film to the sub-surface. Then 11 more cuts are made at right angles to the first so that they produce 100 sections 1/32 in. square. The number of squares remaining attached to the panel is an expression of the adhesion . . .

. . . **R. I. Peters and H. W. Redshaw**, Ditzler Color Division of Pittsburgh Plate Glass Co., "Evaluation of Automotive Finishes."

We realize that current finishes chip on impact, especially across the front of automobiles and along door edges. We're trying to cure chipping, but it's a tough problem because:

Undercoats are highly pigmented to fill well and sand easily. But high pigmentation gives poor film strength. On impact, the undercoat film breaks and the finish chips.

We can make chip-resistant undercoat—but it's hard to sand . . .

. . . **R. B. Davis**, E. I. Du Pont de Nemours & Co., "Trends in New Automotive Finishes."

Labor and equipment are the major factors in painting cost. Methods and apparatus more often control selection of paint materials than the reverse.

Purity of water used for rinsing after phosphate treating and for wet sanding is of newly recognized importance. Excess soluble chlorides and sulfates under paint contribute to formation of blisters. Water containing less than 150

parts per million of total chloride and sulfate ion is not harmful. More than 300 parts per million definitely do lead to trouble . . .

. . . **R. E. VanDeventer,** Packard Motor Car Co., "Automotive Paint Processes and Equipment."

Science of Glamor

Color preference in furniture, household paint, and clothing has been tabulated. The data prove that color preferences are cyclical in nature.

Now that the color range for automobiles is practically unrestricted, we'll probably begin to see cycles here too. Already an oscillation between bright colors and grayed colors is evident. We are now in the middle of a high-chroma, "clean" color era. Grayed, subdued tones will inevitably follow . . .

. . . **S. L. Terry,** Chrysler Corp., "The Science of Glamor."

Car Stability

"Stability" refers to a large and poorly defined group of properties which describes how an automobile reacts to steering.

If there is an appreciable delay between the effort to control and the knowledge of what that effort will cause, then there is not only a period of uncertainty. There is also a limitation to how well the car can be handled.

When cornering force is plotted against slip angle, cornering force does not rise proportionately with slip angle. Instead it lags behind. The amount of lag decreases as tire speed is increased. Also, the delays depend on the rate of steering.

Together, these findings suggest that the lag may depend only on the relation between the steering angle and the distance traveled. Experiments to check this hypothesis show that cornering force always adjusts in the same manner with respect to distance traveled—regardless of timing . . .

. . . **S. A. Lippmann,** United States Rubber Co., "Car Stability and Transient Tire Forces."

Forging and Extruding

Press forging is rapidly replacing drop forging. Press operators quickly become experts, and forg-

. . . Around the Meeting

The Wednesday morning session was a family affair: **Muir Frey** of Allis-Chalmers officiated as chairman and his son **"Stu" Frey** of Ford served as secretary.

S. M. and M. L. Frey

For the smooth operation of the Meeting's technical sessions, SAE is grateful to **chairmen:**

Vincent Ayres, Eaton Mfg. Co.
J. T. O'Reilly, Ford Motor Co.
H. E. Chesebrough, Chrysler Corp.
M. L. Frey, Allis-Chalmers Mfg. Co.
P. W. Tabb, Hudson Motor Car Co.
J. B. Macauley Jr., Ethyl Corp.
R. D. Evans, Goodyear Tire and Rubber Co.
Robert Schilling, General Motors Corp.

And for their services in recording the impromptu discussion at the sessions, SAE thanks **secretaries:**

D. R. Kinker, Chrysler Corp.
E. J. Storfer, Chrysler Corp.
Richard Sinko, Chrysler Corp.
S. M. Frey, Ford Motor Co.
Russell Peebles, Hudson Motor Car Co.
H. A. Toulmin, Ethyl Corp.
M. G. Anderson, Goodyear Tire and Rubber Co.
M. deK. T. Kennedy, Thompson Products, Inc.

Most appreciated golf story told at the Meeting was this one of **S. L. Terry's:** A clergyman and a layman struck up an acquaintance at the club house and went out on the links for a round. The layman, wasting stroke after stroke, finally found himself in a sand trap. He couldn't contain himself any longer and let out a string of oaths.

When this didn't do any good on the next hole, the clergyman suggested, "In our religion, when we get in a tight spot, we pray."

"All right. I'll try it," said the high scorer. But the next stroke was no more productive. "Why won't it work for me?" he demanded.

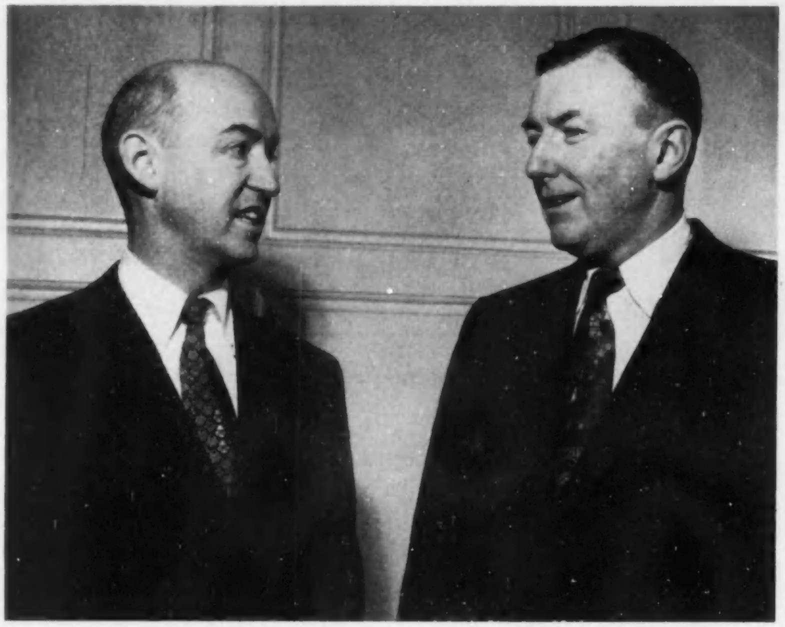
The clergyman's explanation: "In our religion, we keep our heads **down** when we pray."

"Pom's vests" were the acknowledged sartorial highlight of the Meeting. The red-on-cream stripe waistcoat British automotive editor **Laurence Pomeroy** wore while presenting his paper was a mere 50 years old. But the elegant brocaded number with which he graced the evening sessions dates from 1795.

The brocade was made up into a woman's dress and spent a century and a half in a private museum. When the tax squeeze caused the family owning the museum to sell out, Mrs. Pomeroy acquired the antique dress with the idea of making a cocktail dress out of it. Pom convinced her that the material should instead have a turn as the basis of a man's garment.

Laurence Pomeroy

VP's Buehrig and Boegehold are pleased . . .



Two SAE vice-presidents, G. M. Buehrig (left) and A. L. Boegehold confer. Buehrig is vice-president representing the SAE Body Activity and Boegehold is vice-president representing the SAE Engineering Materials Activity. These two Activities plus the SAE Passenger Car Activity Committee—which Harold Nutt represents as vice-president—sponsored the Meeting, with the cooperation of the SAE Detroit Section

. . . with response to program planned by committees headed by Gurski, Kaiser, and Scherger

Success of the Meeting brings smiles to three of the men responsible for finalizing the technical-session program and laying the ground work for next year's sessions. They are Joseph Gurski (left), meetings vice chairman for the Engineering Materials Activity; H. S. Kaiser, meetings vice chairman for the Body Activity; and T. A. Scherger, meetings vice chairman for the Passenger Car Activity

ings are no longer scrapped for want of skill.

Most press forgings are made in only two or three blows. Mechanical ejection allows the designer to reduce draft, thereby saving time and material. Press dies, subject only to squeeze and not to impact, can take inserts of long-lasting steels. Die life is increased also by virtue of short die-forging contact and immediate ejection.

Forging presses are vibration-free and quiet. Their foundations are cheap and trouble-free . . .

. . . **R. G. Friedman**, National Machinery Co., "Trends in Modern Forging."

The secret of successful cold extrusion is to use pressures and speeds best suited to each step. Die design and sequence of operation are very important.

When properly handled, carbon steel is a decidedly plastic material. The lower carbon steels are easier to handle. We find that aluminum-killed, hot-topped shell-quality 1010 will develop ultimate strengths up to 110,000–115,000 psi. Higher carbon steels work harden faster, so that more anneals are often required to achieve final shape . . .

. . . **D. I. Brown**, Mullins Manufacturing Co., "Koldflo Extrusion Permits New Advances in Design."

The Ugine-Sejournet process uses molten glass as the lubricant in the extrusion of steel. The method has increased the length of billets and the ratio of area reduction possible in steel and high-temperature alloys. This makes extrusion a much more valuable process.

Extrusion is generally costlier than hot rolling—but more versatile. It can provide odd-shaped tubes, even in stainless. It can also provide at small cost solid shapes not available by rolling . . .

. . . **S. O. Evans**, Babcock & Wilcox Co., "Steel Extrusion and Its Value to the Designer."

It is generally not economically feasible to produce a part by cold extrusion which can be manufactured on an automatic screw machine with single chucking and requiring removal of only a moderate amount of metal.

If, however, double chucking with the attendant handling is required, or if large amounts of metal must be removed, the part is a good prospect for cold extrusion . . .

. . . **J. F. Leland and J. W. Helms**, Parker Rust Proof Co., "The Influence of Proper Lubrication on the Design of Cold Extruded Components."

Car Shake

Car shake includes only those vibrations which would be perceived by a passenger and which are in the frequency range of about 8–15 cps.

It must be admitted that by far the greatest proportion of the energy involved in high-frequency vibrations originates at the road surface and enters the car structure through the suspension.

Lateral damping introduced between rear axle and frame helps combat shake. Softer tires would help, too—provided the softening was in the radial direction only . . .

. . . **R. R. Peterson**, Chrysler Corp. "The Effect of the Car's Suspension on Car Shake."

Static structural analysis is not the answer to all shake problems. But it is a good beginning.

Satisfactory shake suppression rests upon good balance and tuning of the various mass components as required by their distribution and support and the damping of the system. The elements not considered related to structure are most likely to be sources of shake. The need for rigidity in supports of heavy units cannot be overemphasized . . .

. . . **Mark Garlick**, Pontiac Motor Division, "Structural Properties Needed to Suppress Car Shake."

It takes too long to analyze oscillograms of car shake road data.

We use, instead, an electronic selective threshold analyzer—ESTA for short—to do the job. A vibration pickup sends a signal proportional to the velocity of vibration to ESTA, which integrates it to produce a voltage proportional to the amplitude of vibration. This amplitude-proportional signal is amplified to energize a series of threshold-controlled counters. ESTA delivers data ready for plotting.

During test runs, ESTA sits on the back seat. A gasoline motor-generator in the luggage compartment supplies power . . .

. . . **R. J. Saxon**, Ford Motor Co., "Measuring for Car Shake."

A road test will show us whether or not a vehicle is obsessed with shake. The shake rig and bump rig are laboratory tools for determining where the shake originates.

The shake rig induces vibration into the suspension via a connecting rod on each side of the car. The lower part of each rod is driven by an eccentric driven by a variable-speed electric motor.

The bump rig employs two 4-ft-diameter rolls whose maximum circumferential speed corresponds to 120 mph and whose spacing permits them to support the car's front or rear wheels. Cams fitting over the rolls excite car vibratory motion . . .

. . . **M. Ruegg**, General Motors Corp., "Laboratory Simulation of Car Shake."

The undesirable shake characteristics of the convertible can be attributed specifically to the absence of the structural strength which is inherent in the solid steel top.

The engine of the car seems to hold some promise as an absorber. The mass is ample, and the proximity to the cowl is almost ideal.

In a crude test set-up shake amplitude was reduced 25% by using the engine as an absorber. The drawback of increased engine noise and vibration does not seem too great to overcome . . .

. . . **M. Kamins and W. B. Love**, Studebaker Corp., "Shake Control on Convertibles."

Flexible engine mountings can and do cause shake.

We find that for good road performance, the natural frequency of the engine mounts should be at least 13–15 cps. Otherwise the mounts induce shake as the wheels pass over road hollows or bumps and as the engine is either cranked by the starter or stopped by turning off the ignition . . .

. . . **L. H. Frailing**, Packard Motor Car Co., "Flexible Engine Mountings Can Cause Car Shake."

Foreign Cars

The highly stressed panels of unitary-construction cars magnify high-frequency noise. And on modern cars, the front wheels feed road noise directly into the driving compartment. A leading British designer once remarked that if you took the engine and transmission out of his car and let it roll downhill over a rough road, you still would not be able to hear yourself speak.

In France and Belgium it is argued, when so much road noise is inevitable, why spend time and money on making quiet engines and gearboxes. This reflects the Latin view that quiet cars, like daily baths, are an Anglo-American affectation.

Of course, there are differences in English and American thinking, too. When I criticized the high pedal force required in a certain English car and remarked that it would not appeal to the ladies, the manufacturer replied, "My dear sir, we know that women will drive, but let us not do anything to encourage them!" . . .

. . . **Laurence Pomeroy**, "The Motor," "The Size, Structure, and Shape of European Automobiles."

There is a definite tendency in Britain today to design engines with cylinder proportions approaching square and in some cases over square.

Premium fuels available in Britain today are 82 octane number by the Motor Method and 94 by the Research Method.

Regular grade gasoline costs 54¢ per U. S. gal in England. Of this, 60% is tax.

As to future British passenger car engines, it seems that (1) the L-head engine is finished; (2) the four-stroke poppet valve engine will predominate; (3) the liquid-cooled engine will not be replaced in quantity production . . .

. . . **C. L. Goodacre**, Clifford Motor Components, Ltd., "A Review of Some Contemporary British Passenger Car Engines."

Notes on

Producing Hardened Parts

A. Ironside, Canadian Acme Screw & Gear, Ltd.

Report of Panel on Materials and Heat-Treatment held as part of the SAE International Production Meeting, Toronto, Oct. 29, 1953. Panel leader was J. R. Mott, Canadian Acme Screw & Gear, Ltd.

Rear Axle Shafts

Today rear axle shafts are fabricated from SAE 1033, SAE 1038, and SAE 1046 steels, with larger shafts taking the higher carbon chemistry.

They are usually water or caustic quenched in a press to give a hard case of 600 Bhn and a soft core of 250–350 Bhn. The resulting compressive stress pattern on the surface of the shaft is admirably suited to carrying the torsional service stresses.

Short, stubby, involute splines fitted to close tolerance female splines have improved load-carrying capacities over those of straight-sided long splines with looser fitting tolerances. Some believe that a surface hardness of 450–550 Bhn gives the shafts better impact strength, but longer fatigue life is to be expected at a Bhn of 600.

Passenger axles made from SAE 1033 are now being inductively heated and quenched progressively with excellent results.

Information in the accompanying article was developed by:

J. R. Mott, Panel chairman
Canadian Acme Screw & Gear, Ltd.

A. Ironside, Panel secretary
Canadian Acme Screw & Gear, Ltd.

H. B. Chambers
Atlas Steels, Ltd.

J. S. Edgar
Thompson Products, Ltd.

I. Reid
Ford Motor Co. of Canada, Ltd.

R. W. Roush
Timken-Detroit Axle Co.

R. Smallman-Tew
A. V. Roe (Canada) Ltd.

E. H. Stilwill
Chrysler Corp.

Carburized Gears

Optimum surface carbon concentration for gears of most alloys is 0.90–0.95%. A slightly lower value is best for the more highly alloyed materials such as SAE 3310.

Case depth is measured in several ways. On the floor a cut test bar is usually examined and read to 0.45% carbon level after a nital etch.

Probably the most accurate method is the technique used by Timken Roller Bearing Co. There carburized SAE 4620 test pieces are quenched from the carburizing furnace into salt at 525 F and held for 15 seconds. The test piece is then water-quenched, sectioned, etched, and read by microscope. (The M_s point for 0.50% carbon is 325 F.) After quenching, the dark etching-transformed products of the microstructure represent a carbon level below 0.50% carbon.

Distortion is still a problem in carburizing, especially in gear work. It's important to keep distortion in gears uniform from gear to gear, and from day to day, thus allowing and compensating for it in the machining operation. Good fixtures help in preventing sag during the gear carburizing cycles at elevated temperatures in the furnace. Uniform quenching on all parts of the gear is believed more important than uniform heating. Marquenching has been a useful tool in controlling distortion as a result of nonuniform quenching.

Because of the increase in specific volume in the case that occurs when a piece is carburized and because of the further increase in specific volume when the case and core are quenched, it appears impossible to eliminate distortion. But distortion can be held down. Some believe that minimum

distortion occurs when parts are slow cooled from the carburizing temperature and rehardened from a low temperature around 1425–1450 F.

Ammonia is used in enriched endothermic carrier gas at the discharge end of one furnace. It is believed to reduce the risk of having thin soft skins originate in this zone.

Bolts

Bolts usually carry tensile stresses axially through the part. Therefore to get maximum load-carrying capacity for the part, it is necesary to quench and draw it so as to obtain uniform hardness throughout its cross-section. SAE 1038 is satisfactory when oil quenched and drawn in sections up to 0.350 in. in diameter. Over 0.350 in. in diameter a small amount of alloy is added to insure a uniform hardness throughout the cross-section.

SAE 1030 material is often used up to 0.500 in. in diameter when water quenched and drawn.

(The report on which this article is based is available in full in multilithographed form together with reports of the seven other panel sessions of the SAE International Production Meeting. This publication, SP-305, is available from the SAE Special Publications Department. Price: $1.50 to members; $3.00 to nonmembers.)

Airline Passengers . . .

. . . are getting a smoother ride these days, but gust loads on the planes have increased because they are flying through turbulence more often.

Based on paper by **T. L. Coleman and Roy Steiner** National Advisory Committee for Aeronautics

DATA that NACA has accumulated over the past 20 years indicate that the riding comfort of transport airplanes is improving due to changes in aircraft design. They show also that gust loads have increased slightly due to the more severe turbulence being encountered.

Estimates of the gust loads on future jet transports indicate that the benefits derived from high-altitude operations may be lost if efficient operations require high speeds during climb and descent.

The recent improvement in riding comfort appears to be due to the increased wing loading and the higher operating altitudes of postwar aircraft. Fewer gusts are encountered at the higher altitudes.

However, from the velocity-acceleration-altitude (VGH) data collected, it is evident that slightly greater turbulence has been experienced in the last few years than in most of the earlier operations. Turbulence varies considerably from route to route.

Even though the newer transports benefit from the smoother air at their higher cruising altitudes, they encounter compensating gust conditions during their climb and descent through the lower altitudes. One reason for this gust picture may be that current operating and dispatching practices permit take-offs and landings through rougher weather. Another reason may be that there is increased flying at night when turbulence avoidance is more difficult. Possibly also the picture is influenced by failures to forecast rough weather at flight destination.

The VGH data make it clear that airspeeds have had little effect on the trend toward increased loads and that the increase is due to the higher gust velocities encountered.

Examination of the time-history records shows many cases where the turbulence was evidently more severe than the pilot expected or else lack of sufficient advance warning prevented slow-down.

Most of the turbulence recorded at high speeds occurred during descent. Therefore, control of airspeed during descent appears to be of particular importance in reducing the loads. Best piloting practice to reduce loads is, in fact, prompt reduction of airspeed at the first indication of rough air, no matter whether the plane is descending, climbing, or in level flight.

Analysis for Jets

Future jet transports will have their problems, too, it appears. Using our gust data, we calculated gust loadings on jet planes for three assumed flight paths. Indications are that future transports which operate at high climb and descent speeds will experience fewer small accelerations but more large ones.

Approximately three times as many acceleration increments of 1.0 g, for example, would be expected. The larger values result primarily from the high airspeed in climb and descent at the lower and more turbulent altitudes. Reduction in turbulence gained by operating at high altitudes may be more than cancelled if the airplane is operated at high speeds during climb and descent.

If future transports climb and descend at low speed, they'll encounter only about half the acceleration increments of present operations. However, reductions of the order of one half are not considered very significant in the load history of transports.

(Paper "Some Trends in Gust Loads for Transport Airplane Operations" was presented at the SAE National Aeronautic Meeting, Oct. 2, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

SAE Student News

University of Michigan

"The Evolution of a Sports Car" was presented by Maurice Olley at the January 6 meeting. Olley is director of research and development at Chevrolet.

He traced the development of the American automobile and showed how the contrasting desires of the younger and older generation influenced the automobile's development. He showed that if Detroit was going to meet the needs of the younger generation, the next logical step in the evolution of the American Motor Car is Chevrolet's Corvette.

Olley described the various mechanical features of the Corvette chassis, suspension, engine, and body. He emphasized the fact that Corvette was not intended to be used as a racing car. But, he seemed to think that it will undoubtedly be converted into one by various owners.

After Olley's talk, a movie of Mauri Rose driving the Corvette on the proving grounds was shown.

The afternoon prior to Olley's talk, a Corvette was on display near the engineering buildings.

Following the film, John Coffin, staff engineer with Chevrolet, demonstrated the making of plastic for the bodies. He told the students that the plastic is extremely flexible. Some of the plastic sections could be pushed in four inches without damage. Coffin also said that the plastic will burn, but needs an external source of heat to maintain combustion.

California State Polytechnic

"Powder Metallurgy" was the subject presented by Thomas J. Zilka at the branch's first meeting of 1954. Zilka is head of the Mechanical Engineering Department at the University.

He explained that powder metallurgy consists basically of placing powdered metals under tremendous pressures to form required parts that are later sintered in a furnace. He said that the process was first used about 1937 on pumps and gears, but since then wider applications have been found. This has resulted in improved production methods.

Some of the advantages of powder metallurgy brought out by Professor Zilka were: no scrap, nothing to machine off, and a lighter product. Speaking about disadvantages, he said that the basic powders are costlier than the ingot material.

The range of its uses, Zilka said, explains the importance the process plays in the modern era of industrialization. For example, the process has been extended from its start in pumps and gears to include bronze bearing bushings, jet engine compressor blades, spot welding electrodes, and even stainless steel burning torches in its powdered form, besides many other things.

Future applications will include: piston rings, aircraft skins, jet engine turbine blades, refrigerator compressor parts, and others. Some of these are now in an experimental stage.

The talk was supplemented with examples of parts manufactured by the process, and a brief outline on limitations, methods, and recommendations in basic powder metallurgy design.

Stanley D. Adkins, student chairman, presided.

University of Pittsburgh

SAE's Student Branch received an award last January 14 for sponsoring the seminar most successful in stimulating student participation in extra-curricular activities during the previous semester.

The award was received on behalf of the branch by the fall semester chairman, Ralph Knapp, and present chairman, Bob Varga. The presentation was made during an assembly of all engineering and mines seminars.

Plans for the spring term include field trips to companies, joint meetings with the Pittsburgh Section, speakers from industry, and a social event.

University of Oklahoma

John Dickmann, Mid-Continent Section's program chairman, and George W. Cupit, also a Mid-Continent member, were guests at the February 17 meeting. Dickmann is automotive engineer for E. I. du Pont de Nemours & Co. in Tulsa, and Cupit is vice-president of DanCu Chemical Co., Oklahoma City.

Guest speaker was R. M. Tuck, who is assistant chief engineer of the design section of transmissions, Allison Division, GMC, Indianapolis.

Tuck discussed several hydraulic systems. He explained the mechanics involved, testing and testing equipment. He concluded with the merits of different kinds of hydraulic transmissions.

Student Chairman John Borden presided, and Bob Jeffiries introduced Tuck.

Plans have been made for a joint-meeting of the Student Branch and the Mid-Continent Section next May 5.

University of Wisconsin

"Formulation of Heavy Duty Motor Oils" was the subject presented by Irving S. Quale of Sinclair's Research Laboratory at the February 17 meeting. With Quale was C. V. Chapelle, Sinclair sales engineer who presented a demonstration and showed a 15 minute movie.

New Student Branch

Members of the newly formed SAE Student Branch at George Washington University are shown at the February 16 meeting of the Washington Section. Their advisor is Professor Charles E. Greeley of George Washington (front row center) who is also chairman of the Washington Section Student Activity.

from the Sections

"**Ambitious**" seems to be the only way to describe Section activities. An imaginary space trip (St. Louis Section), a Ladies Night (Twin City), Small Car Symposium (Buffalo), Steel Symposium (Detroit), and Sports Cars Symposium (Metropolitan), were highlights of the recent Section activities. Even cold weather (nine degrees) couldn't keep Wichita members home.

Buffalo

Field Editor
D. I. Hall
Feb. 11

FOR 9500 MILES of driving per year, the standard American heavy car (about 3825-lb) costs **$248** to run, according to Miguel Ordorica, Willys' chassis and military chief engineer. The standard American car (about 3225 lb), he said costs about **$163** a year to run . . . but the American light car about (2500 lb) costs only about **$108**.

It's this **lower operating cost**, he believes, which is the "extra something" the light car must have to attain sales.

He stressed the reduction in **car density** on the streets in cities, towns, and villages that can be accomplished by the widespread use of the small car. Through the adoption of both length reductions (to 15-ft) and **width reductions** (to five feet, which could result in another lane on a 40-ft wide street), it would be possible to increase the vehicle density by 41%.

Milton Bald, on the other hand, said, "The purpose in designing the so-called 'light' cars of today is to obtain **compactness without sacrifice** of passenger capacity or comfort." Bald is staff engineer with the Hudson Motor Car Co.

Comparing the Hudson Jet with the 1954 models of "the big three," Bald said that the shipping weight of "the Big Three" cars averages 20% more than the Hudson Jet; also the overall lengths are up to 18 inches greater . . . and yet front seat leg room of the Jet is within an inch of "the Big Three." Rear seat leg room is within three inches, and shoulder and head room are equal in all cases.

L. H. Nagler, executive technical adviser for the Nash Motor Division, agreed with Bald that compact cars differ substantially in exterior dimensions from big cars, but are virtually identical with respect to interior passenger area. Speaking about **unitized body** contruction used in producing most small cars, Nagler stressed greater safety. "Occupants have a better chance to walk away from a **serious accident**, if they have been riding in a car with a unitized type body."

Metropolitan

Field Editor
Leslie Peat
Feb. 9

THE MOST AMBITIOUS and successful meeting of Met Section within this field editor's memory took place on February 9 when an afternoon sports car symposium, followed by a dinner-meeting, brought out more than 300 members and guests.

Many of the world's outstanding authorities on **sports cars** were on hand: Charles Chayne, vice-president of GMC; Laurence Pomeroy, technical editor of "The Motor," London; Ellis J. Premo, who is in charge of the Corvette production at Chevrolet and Z. Arkus-Duntov, also of Chevrolet.

Speaker of the evening was C. Gordon Benett, who was introduced along with other honored guests, by Sir William L. Welsh.

P. M. Heldt, dean of automotive **technical writers,**

Pittsburgh (Feb. 23)

From Section Cameras

A chairman's certificate is presented to Kenneth G. Scantling (right), last year's Section chairman, by the present chairman, Robert Kirkpatrick (left).

Displaying 25-year certificates (left to right) Dr. Paul V. Faragher, in charge of metal products specifications in the Metallurgical Division of the Aluminum Co. of America; J. A. Harvey, a past vice-president representing the Transportation and Maintenance Activity, now coach sales representative for GMC's Truck & Coach Division in Pittsburgh; and John Orr, the second chairman of the Pittsburgh Section and another past vice-president representing the T & M Activity. At extreme left is Chairman R. L. Kirkpatrick, who made the presentation.

was awarded life membership in the Society by Past-President Robert Cass. Cass came from Cleveland to make the presentation which had been voted on by SAE Council.

Herb Shriner, TV star and sponsor of the International Motor Sports Show, was awarded a plaque for his achievement as a leader among sports car enthusiasts by Alfred Reeves. Reeves is consulting vice-president of the Automobile Manufacturers Association.

The technical forum was moderated by Phillip H. Pretz of Ford Motor Co., last year's chairman of Detroit Section. The meeting was planned by R. M. Cherryholmes, Shell Oil Co., and his committee: Charles E. Chambliss, Jr., Chevrolet Motor Division, GMC; Robert W. Hogan, Ethyl Corp.; and S. G. Tilden, Jr., Permafuse Corp.

Feb. 19

SMOOTHNESS in the operation of heavy commercial vehicles is a goal sought by many inventive minds. These minds are now exploring the possibility of adequate electrical, pneumatic, hydraulic or improved mesh-gear transmissions. The range of engineering thinking being done on this problem was outlined by Merrill C. Horine. Horine is consulting engineer of Mack Mfg. Corp.

He said that **automatic transmissions** are needed in the highway transportation industry and should satisfy the following requirements:

1. Be compact enough to be used on short wheel-based tractors and COE chassis
2. Be no heavier, or not very much heavier, than today's gear transmissions
3. Have a useful life of 500,000 miles and overhaul intervals of 100,000 miles
4. Have **mechanical efficiency** as high as the conventional gear trains of today
5. Be readily accessible for maintenance
6. Be simple to maintain, lubricate and adjust
7. Be built at low cost.

Horine was of the opinion that a hydraulic system would be preferable to pneumatic transmissions. Already automatic transmissions are being offered on smaller trucks as **optional equipment.** Many millions of miles of automobile experience have paved the way for acceptance of just this kind of transmission.

Hawaii

Field Editor
R. G. Deemer
Feb. 15

THE GREATEST ENEMY of the injection system is dirt and any measures taken to preclude dirt entering the system would lengthen life **between repairs.** This was just one of the points stressed by panel members in their discussion of diesel pump and injection systems.

The panel also agreed that reliability is **the first requisite** of these systems. All the manufacturers have changed parts of their systems as engines have changed—in order to improve the reliability.

In spite of this, the panel thought operating conditions have a great share in determining reliability. For this reason, the operator wants a simple, **easy to repair** system as a second requisite.

Panel members were: Albert Ruegg, sales engineer, truck department, von Hamm-Young Co.; Robert Rex, maintenance superintendent, Oahu Sugar Co.; C. H. Bartlett, service manager, Caterpillar Division, Theodore H. Davies, & Co., Ltd.; William Mello, superintendent of maintenance, Honolulu Rapid Transit Co.; Leonard Lister, shop superintendent, Waialua Agricultural Co.; Ed Westerback, Oakland District service manager, International Harvester Co.; Ward Deffenbaugh, Western regional service manager, International Harvester Co.

T. Cowley, automotive engineer for Libby McNeill & Libby, was moderator for the discussion.

Dayton

Field Editor
P. J. Long
Feb. 18

THE DESIGNER may do a perfect job of functional designing, but this is of no avail if the material and processes by which the resulting product is made, price it out of the market. This is what A. S. Jameson told members at the February meeting. Jameson is supervisor of the Metallurgical Laboratories, International Harvester Co.

He pointed out the necessity of **close collaboration** between designers, production men, and metallurgists. To design, manufacture, and sell a product, he said, is the job of a team—not a series of more or less **independent actions** by each specialist.

Jameson also covered in detail cold working, hardenability, machinability, directionality, decarburization, and other items affecting physical properties of materials which the designer encounters.

Northern California

Field Editor
R. E. Van Sickle
Jan. 27

THE PROPER MENTAL ATTITUDE that should be maintained for development of new and improved automotive and petroleum products was stressed by H. C. Mougey. Mougey is retired technical director of GMC's Research Laboratories Division.

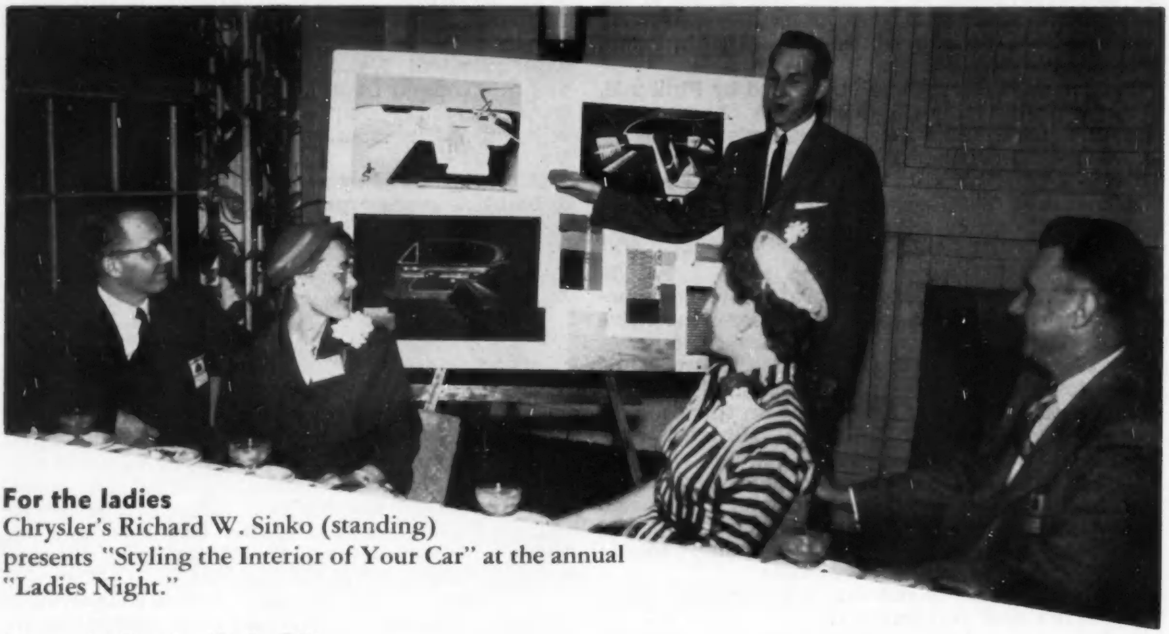
He quoted C. F. Kettering, a past president of SAE, from "Motor," of January 1924: "The important thing is that we have learned to wish for **something unreasonable**—and then go out to make the unreasonable thing something that everybody can have as a matter of course."

Describing the change in mental attitude during the past 40 years, Mougey said many people used to believe that desired lubricants could be obtained by specifying a list of properties, such as gravity, viscosity, flash, fire, color, and so forth.

"Now, it is recognized that, although these vari-

From Section Cameras

Twin City (Feb. 10)



For the ladies
Chrysler's Richard W. Sinko (standing) presents "Styling the Interior of Your Car" at the annual "Ladies Night."

Central Illinois (Feb. 22)

Speakers and officers get together during the February meeting of the Section. Left to right: T. L. Schepke, Peoria Airport Authority, and after-dinner speaker; W. E. Bettoney, assistant technical manager, technical section of the Petroleum Chemical Division, E. I. du Pont, and main speaker for the evening; Dr. Richard Wiebe, head of the motor fuels evaluation section, Northern regional laboratory, U. S. Dept. of Agriculture, technical chairman for the meeting; and Vice-Chairman H. R. Johnson, supervising engineer, Caterpillar Tractor Co., Peoria.

ous properties are of importance, their principal value is in **checking the identity** of various oils and determining whether or not an oil is similar to a previous oil whose value has been determined by actual tests."

Mougey said, however, that the test of any product is the performance of that product in actual service.

Wichita

Field Editor
W. E. Shelor
Jan. 20

THIRTY-SIX HARDY MEMBERS showed up at the January meeting despite the nine degree weather. Al Roesing took over in the absence of Herb Rawdon, Section chairman, and called the meeting to order.

Speaker for the evening was John R. Berg, head of Wichita University's Geology Department. In speaking about **"Oil Exploration,"** Berg mentioned four requisites for an oil pool: (1) source rock, (2) reservoir rock, (3) cap rock, and (4) structure.

Slides were then shown as well as a film "Ten Thousand Feet Deep."

Field Editor
V. H. Adamson
Feb. 17

UP-TO-DATE commercial regulations are necessary with the advancement of high-speed and high-altitude aircraft. This was stressed by Edwin G. Bracher, supervisor of the B-47 Flight Test, Boeing Airplane Co., Wichita, Kansas.

Bracher, who has tested more than **70 kinds** of aircraft which have taken him into every country in the world (except Finland), reviewed the history of older type aircraft up to **the modern jet.**

Bracher climaxed his speech by giving a true story of taking his own infant daughter from Stockholm, Sweden, to a **baby-sitter** in New York and returning to his duties in Stockholm in less than 60 hours.

Canadian

Field Editor
F. G. King
Jan. 20

CONTINUED DEVELOPMENT of tractor-mounted implements has given not only more economy, but faster harvesting. Under many weather conditions this has meant the difference between **total loss** and good return. This is what speaker S. M. Young told members. Young is divisional chief engineer, International Harvester Co. of Canada, Ltd., in Hamilton, Ontario.

Young also said that every vehicle propelled by an engine comes within the sphere of automotive engineering, and as such, farm equipment is important business. Colored slides giving details on the Grain Combine, the Cotton Picker and Sugar **Cane Harvester** were shown along with the presentation of Young's paper, "Automotive Engineering as Applied to Farm Equipment."

Western Michigan

Field Editor
C. K. Messner
Feb. 16

TURBINE POWERPLANTS FOR CARS aren't going to be common in motor vehicles for a while, in the opinion of E. F. Lewis of GMC's Truck & Coach Division. For tough, heavy duty service, the diesel is **still the favorite,** he said . . . and he sees nothing on the horizon likely to change that status in the immediate future.

"The diesel engine," Lewis told this meeting, "is the predominant heavy-duty powerplant in the motor bus industry today. Approximately **90% of all GM buses** produced in 1953 had diesel powerplants."

Automatic transmissions, Lewis believes, will continue to come fast in the bus field. He thinks their application to buses will closely approximate their rapid adoption on passenger cars.

Detroit

Field Editor
W. F. Sherman
Feb. 1

AUTOMATION eliminates drudgery and hazards. Thus it makes jobs better for the stamping plant employee. That was what A. J. Hole told members at the "New Techniques in Sheet Steel Processing" symposium of the Engineering Materials Activity.

("Automation," according to Hole, is a coined word meaning the automatic handling of parts in process and includes such things as conveyors and air and hydraulic systems.) He thought that **productionwise,** it is not possible to feed presses fast enough by hand to keep them running continuously.

J. F. Brick said that Rockwell and Olson cup tests alone are not a good test of ductility, in his paper, "Drawing Requirements of Cold Rolled Sheets." Complete laboratory testing is utilized, but the **proof of quality** is obtained only by making the stampings and determining what the results are.

In discussing high-strength, low-alloy steel for plated parts, C. L. Altenburger said, "orange peel" and **"stretcher strains"** are particularly difficult to deal with. He is research engineer with the Great Lakes Steel Corp. Because carbon steels are subject to strain aging, they have proved less desirable than the low-alloy materials and, in addition, the latter permit lighter stampings to be utilized. Thus, there has been a substantial trend to the use of a low-alloy material for these parts.

Adam Zimmerman, of Acme Mfg. Co., told members that it usually costs less to prepolish hot rolled steel than the price differential between this and

From Section Cameras

Atlanta Group (Jan. 18)

In honor of his long-time membership in SAE, Fletcher Brown, (extreme left) manufacturing manager of Lockheed's Georgia Division, was presented with a 25-year certificate. Left to right are: Brown; Zach Layfield, chairman of the Atlanta Group; Jack Reid, vice-chairman; L. C. Malone, a member of the Group and manager of procedures & facilities for Lockheed; Robert Anderson, chief engineer, Plymouth Division, Chrysler, Detroit. Anderson came to Atlanta to address the Group.

St. Louis (Feb. 4)

An imaginary flight in space was the subject of Dr. Wernher Von Braun, technical director, guided missile group at Redstone Arsenal.

Northern California (Jan. 27)

Ready for dinner and talk are: (left to right) Chairman J. A. Edgar; H. C. Mougey, retired technical director of the Research Laboratories Division of GMC, and speaker for the evening; and V. C. Peterson, vice-chairman of the Transportation and Maintenance Activity, as well as chairman of this meeting.

cold rolled steel. Zimmerman said, too, that prior to the last World War, flat polishing was done on reciprocating bed machines, and principally on stainless steel sheets. The automobile industry's change from hot forgings to cold stampings was due principally to radical changes in styling.

However, only hot rolled steels were available for bumper manufacturers, and the surface condition of these steels presented a serious problem in metal finishing prior to plating, especially costwise. This led to **prepolishing** the steel before it was stamped, with the material fed in coil form into the machine. For this kind of work, the speeds vary from 20 to 60 feet per minute.

E. F. Lundeen, quality control specialist of Inland Steel Corp., said that despite the demands of automation for better quality in steel finish, the savings in material handling and other processing steps actually makes it economic to accept coils of steel which have some defective lengths in them, inasmuch as the savings frequently offset rejections amounting to as much as 15 per cent.

St. Louis

Field Editor
A. W. Zub
Feb. 4

TRAVELLING TO THE MOON is possible if we want to spend money for it. That was what Dr. Wernher Von Braun told Section members during an imaginary space trip. Dr. Von Braun is technical director of the guided missile development group, Redstone Arsenal, Huntsville, Ala.

He said that sufficient technical knowledge has been gained for the first step on the way to the moon—construction of rockets that could function as **artificial satellites** of the Earth. Rockets have already been fired that have attained an altitude of 250 miles. In order to accomplish a proper balance between centrifugal force of flight around the Earth and the Earth's gravitational attraction, a satellite ship would have to attain a speed of 18,468 mph at an altitude of 1075-mi. There it would enter an orbital flight pattern and circumvent the Earth every two hours. With proper **radar and television** equipment, the most habitable parts of the Earth would be under observation once every 24 hours.

Monkeys would be the first passengers on the flights to outer space, Von Braun said. Television cameras could study the reactions of the animals, along with every conceivable instrument used to record or transmit pertinent data back to Earth.

Dr. Von Braun also mentioned a space platform that would revolve around its own axis to create centrifugal force against the rim, thereby allowing men to be able to walk and live in a more natural manner. After enough material is transported to the platform, then it would be possible to send a ship from the space platform to the moon. Since the platform would already be traveling at a speed of 18,468 mph, only an additional push would be necessary to carry it out of the **orbital path** to enter another path that will travel around the moon and back.

Twin City

Field Editor
S. H. Knight
Feb. 10

TO GIVE THE LADIES a conversation-piece that will last several bridge sessions was the avowed purpose of this "Ladies Night" meeting. It reached its goal by talking automobiles in terms designed to elicit feminine interest.

Chrysler's Richard W. Sinko talked of **paint colors** and fabrics, of testing them for durability. Both color and fabric textures have definite psychological and **physiological effects**, he pointed out.

Then Chrysler's assistant director of styling went on to tell of his corporation's "idea" cars . . . the K-310, the C-200, the Special, the D'Elegance, the DeSoto Adventurer, and the Dodge Fire Arrow.

Northwest

Field Editor
W. M. Brown
Feb. 5

THE COST of getting logs out of the woods has progressively increased during recent years to such a point that the ultimate consumer begins to ask whether lumber is sold by the pound or by the board foot. This is what S. S. McIntyre, Jr. told the Section. He is chief engineer for the Skagit Steel and Iron Works.

The Skagit Steel and Iron Works has recently added to their line mobile yarder types of equipment designed to reduce the cost of getting logs out of the woods and loading them onto hauling units. Since setup time is reduced, it becomes economical to log small stands of timber as well as large.

Central Illinois

Field Editor
W. J. Lux
Feb. 22

TO FORESTALL PREIGNITION, a more fundamental approach to the problem is needed than simply adding chemicals to gasoline. This was W. E. Bettoney's opinion at the Section's February meeting. Bettoney is assistant technical manager, technical section of the Petroleum Chemical Division, E. I. du Pont de Nemours & Co.

Since deposits are a basic trouble, various methods of removing these deposits such as **commercial mixtures,** low-octane fuels, water-alcohol mixtures, and carbon particle injection, have been considered possible aids. Bettoney thinks these do little good, and that all have **detrimental effects.**

He said that the best way to remove combustion-

From Section Cameras

Sacramento-Stockton Division, Northern California (Jan. 20)

Happy foursome standing behind the table are: (left to right) J. A. Edgar, chairman of the Northern California Section; A. P. Labrucherie, chairman of the Sacramento-Stockton Division; H. K. Holm, guest speaker; and D. C. Hackney, the Division's meetings chairman.

"Ram jets and helicopters" was the subject of speaker H. K. Holm, of Hiller Helicopter Co. of Palo Alto, California.

Washington (Feb. 16)

Past President D. P. Barnard (right) is shown talking with Chairman Jim Redding. Barnard has been newly appointed Deputy Assistant Secretary of Defense (March Journal, p. 98).

B. J. Vierling (right), meetings chairman, and Glenn Evans of the Glenn L. Martin Co., who was speaker.

chamber deposits is to remove the head and scrape it. Another possible source of relief is to prevent the formation of deposit material in combustion chambers. Certain **metal salts** are useful, he said, but they must be relatively cheap, or else economic limitations present themselves.

Philadelphia

Field Editor
Paul Kennedy
Feb. 10

"WORK-HORSE VEHICLES" will realize most advantage from the torque converter. That's what Myron Schall, hydraulic transmission engineer of Spicer Division of Dana Corp. told the Section.

With the recent development of **dynamic braking**, Schall predicted, heavy-duty tractor trucks will soon incorporate a torque converter in the drive line. This and other industrial applications, he said, must show net cost savings to the operator to **be competitive.**

Washington

Field Editor
C. Janeway
Feb. 16

HIGH PRODUCTIVITY per man has been achieved by the Glenn L. Martin Co. in Baltimore. This has been accomplished by having fixed worker stations, fixtures permitting work accessibility, no hand fitting, and **automatic handling**. This was pointed out by Glenn Evans during the presentation of "How the British Canberra Bomber Became the USAF B-57." Evans is tooling manager for Glenn Martin.

He said, too, that despite wide differences in U. S. and British wage rates, our production methods offset the rate spread—resulting in equal cost per unit, even **lower U. S. cost** per unit, if production is of sufficient quantity.

Pittsburgh

Field Editor
O. B. Rosstead, Jr.
Feb. 23

THE 1954 FORD V-8 TRUCK has two outstanding accomplishments: the degree of rigidity obtained in the entire structure, and the increase in horsepower while maintaining practically the same displacement compression ratios. This was what Ford's John W. Asselstine told the Section. He is supervisor of commercial engine design.

Asselstine also mentioned new cylinder heads that have such rigidity that the number of hold-down bolts could be reduced from 24 to 10, and an all-steel cylinder head gasket could be used which provides better heat transfer. The cylinder heads, incidentally, are interchangeable—right and left.

Another innovation on the engines that was used on some of the '53 engines is the Ford "Depopper." The Depopper is used in the carburetor to eliminate explosions and "popping" in the exhaust system of the engine when the throttle is closed and the truck is over-running the engine—as on a downgrade.

Southern New England

Field Editor
A. D. Nichols
Mar. 3

SAFETY is getting primary attention from automobile manufacturers now that engines are producing greater power. That was the opinion of Laurence E. Crooks at the joint meeting of the Section and Yale's Student SAE Club. Crooks is Consumers Union automotive consultant. He said that **power brakes** are one of the more important advances made in this direction.

Pictures of most of the '54 cars and charts of horsepower, torque and power factors were displayed. A picture taken at the Indianapolis Speedway, "The Big Race," was shown.

Cincinnati

Field Editor
E. B. Lohaus
Feb. 22

THE DAYS OF THE HORSE on the treadmill on through steam power and today's gasoline and diesel-driven excavating machines were covered by H. S. Robertson. Robertson, who is district representative for Bucyrus-Erie, presented his paper, "History & Developments of the **Power Shovel** and Crane."

Movies were shown of cranes that roll on rubber tires, that crawl on tracks, and that walk on boxy feet. Along with the machines, various front-end attachments were described in the film.

Williamsport

Field Editor
Paul Cervinsky
Mar. 1

BUSINESS AIRCRAFT LOGGED 2,000,000 hrs in the first six months of 1953, while scheduled airlines logged 1,240,700 hours, using 1,061 airplanes. That's what Fred Strickland, chief design engineer for Piper Aircraft told members. Some other statistics brought out by Strickland were:

1. Before World War II, only 400 firms owned

business aircraft. Now 8,000 companies own over 10,000 planes of which 1800 are multi-engine.
2. **The average business airplane** use is over 600-hrs annually.
3. In 1952, business airplanes totaled 520,000,000 miles or 3,250,000 hours. The airlines logged more miles but only 2,625,000 hrs.

He said, too, that the Piper Apache has an important role as a "business airplane." It was conceived by the Piper organization to fulfill the need created by the birth of the business-owned and operated **aircraft fleets.**

Colorado

Field Editor
P. G. Anderson
Feb. 25

RECENT DUST STORMS in the area made Jules P. Kobacs' paper, "Filtration of Internal Combustion Engines," timely and of particular interest to members. The facts presented concerned **engine wear** through filtration of foreign matter in the lubricant.

H. R. Otto, chief engineer of Purolator Products, Corp. presented the paper.

Field Editor
J. N. Gromer
Jan. 28

FORTY-THOUSAND POUND CAPACITY steering and driving axles are the features of a new power tractor that was seen at an advance showing when Section members were guests of Coleman Motors.

Paul G. Anderson, service manager for the company, outlined general drive detail mechanism used **in all wheel drive** trucks. Anderson also discussed advantages of different steering type power joints and explained design features of power divider mechanisms.

Kansas City

Field Editor
M. L. Werth
Feb. 26

AUTOMOTIVE STYLE is developed from the physical limitations of wheelbase tread, baggage and engine compartments, and passenger requirements. That's what Willys P. Wagner of Ford Motor Co. told members. Wagner has styled Canadian, German and French vehicles as well as commercial and passenger vehicles for Ford.

He said that after these requirements are met, **the lines and trim** are added for comfort, eye appeal and beauty to conform to the modern trend, as well as **for safety and performance.**

A nominating committee was elected for the current year, consisting of the following members: Roy G. Horridge, Robert R. Mead, Louis Mecklenburg, Ed Nida, Don G. Reed.

Texas

Field Editor
R. W. St. Aubin
Mar. 2

PLANS TO SPONSOR TWO HIGH SCHOOL STUDENTS to the Professional Engineers Dinner this Spring have been made. Students are picked from the high schools in the Dallas area and sponsored by professional organizations to encourage them in **engineering careers.**

By the way, SAE Council has approved the transfer of the San Antonio Division from the Texas Section to the Texas Gulf Coast Section. All concerned are appreciative of the generous attitude of Texas Section in endorsing the transfer of territory.

Milwaukee

Field Editor
D. R. Neeld
Mar. 5

BETTER IGNITION is possible with 12 volts in some respects, but there is still plenty of room for improvement—especially when it comes to the plug fouling problem. That was A. L. Brownlee's opinion at this meeting. He is vice-president in charge of engineering for Wico Electric Co., West Springfield, Mass.

Brownlee said that it is the feeling of many engineers that unless means can be taken to alleviate the **spark plug fouling** situation at its source, then some form of high frequency ignition will find use because of the demand for better ignition performance.

He said, too, that an improvement is indicated at the **higher engine speeds** by reason of the shorter time in which current can be built up in the primary. But he thought that part of the advantage is usually compromised in favor of lowering primary current and increasing the inductance to gain some extra point life.

Mohawk-Hudson

Field Editor
L. F. Smith
Feb. 9

RAPID NATION-WIDE transition from steam to diesel-electric locomotives presented a challenging educational problem to the railroads and to the American Locomotive Co. Members of the Mohawk-Hudson Group attended a conducted tour of the ALCO **Diesel-Engine School** that was founded to solve just this problem.

Stanley Lodge, who has been supervisor of the school for the past two years, explained how and what the students learn. A movie on diesel-electric **locomotive maintenance** on the Santa Fe railroad was also shown to members.

TECHNICAL COMMITTEE *Progress*

SAE Group Studies Helicopter Engine-Propeller Attachments

THREE groups concerned with helicopter engine-rotor attachments tackled a number of problems at a recent joint meeting.

Two of the groups are the existing Committees E-21 and S-2's Joint Panel on Configuration and Committee S-2's Panel on Project No. 50, Helicopter Powerplant Requirements. The third group comprised individuals interested in turbine engines for helicopters.

Here are some of the steps the groups have taken:

• They have recommended that spur gears, rather than planetary gears, be used for reducing turbine engine rpm to the range usable by the rotor. The gears not only reduce rpm; they also permit the engine output shaft to be located above the centerline of the engine.

This wouldn't be necessary if the power take-off end of the engine faced the rotor—but it doesn't with roof-mounted engines for two reasons: (1) The power take-off of the turbine already designed for helicopters has been placed at the rear end to leave the inlet end unobstructed. (2) It is desirable to have the engine aft of the pilot so that there's no chance of the engine crushing the pilot in case of a crash landing. Therefore, the power take-off is several feet aft of the rotor and facing away from it.

Spur gears have sufficient offset to make the required connections with one less turn than planetary gears would need.

• The groups decided to survey the helicopter industry on torque tube practice to find out what combinations of torque transmitted and rpm are used. Some companies, it is known, work with low torque transmitted at high speeds, up to 10,000 rpm. This saves weight and bulk, but may lead to bearing troubles.

The groups aim to discover what currently is the best engineering compromise between bulk and bearing trouble.

• Members of the three groups have

Continued on Page 112

1954 SAE Technical Board

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F. N. Piasecki
B. G. Van Zee

These reports have been approved recently by the SAE Technical Board . . .

AS THE VISCOSITY OF WATER GOES, so goes the kinematic viscosity of lubricants. Thus a revision has been made in the SAE General Information Report on Corresponding Ranges in Kinematic, Redwood, and Engler Viscosities.

It's all because the National Bureau of Standards recently adopted a new value for the viscosity of water (1.0038 centistokes at 68 F). This was done because the NBS found a more accurate way to evaluate the viscosity of water.

As a result, the centistoke values listed in the 1953 SAE Handbook on page 313 have been revised accordingly by the SAE Fuels and Lubricants Committee.

HYDRAULIC POWER PUMPS: A revision in the SAE Standard for Hydraulic Power Pumps calls for chamfering the end of the spline shaft. This change was suggested by the SAE Construction and Industrial Machinery Technical Committee.

CRAWLER-TRACTOR POWER TAKE-OFF: A number of revisions have been made in the SAE standard previously known as: "Rear Power Take-Off and Mounting Face." At the recommendation of its author committee, the name of this standard has been changed to: "Industrial (Track-Type) Tractor Equipment Mounting."

SAE Section Meetings . . .

Canadian—April 30

Prince Edwards Hotel, Windsor, Ont., Canada. Dinner 6:30 p.m., meeting 8:00 p.m. Meeting the Challenger—Paul S. White, vice-president, Aluminum Co. of Canada.

Central Illinois—April 13–14

Earthmoving Industry Conference. (Please see box at bottom of this page.)

Chicago—April 8 and 20

April 8—Illinois Institute of Technology, Chicago. Dinner 6:45 p.m., meeting 8:00 p.m. The 1953 Mexican-Pan-American Road Race—J. R. Gillette, assistant manager, Lincoln-Mercury Div., Ford Motor Co. Short technical papers by winners of student paper contests at Illinois Institute of Technology, Aeronautical University, and Northwestern Technological Institute (competition for grand award).

April 20—Knickerbocker Hotel, Chicago. Dinner 6:45 p.m., meeting 8:00 p.m. Holding the Reins on 300,000 Horsepower—James C. Wise, assistant to the chief engineer of Accessories Section, Marquardt Aircraft Co. Social Half-Hour 6:15 to 6:45 p.m., Bendix Products Div.

Cincinnati—April 26

Engineering Society of Cincinnati. Dinner 6:30 p.m., meeting 8:00 p.m. Advantages of Gas and Diesel Fuels—Merrill C. Horine, consulting engineer, Mack Mfg. Corp.

Cleveland—April 12

Mayflower Hotel, Akron, Ohio. Dinner 6:30 p.m., meeting 7:30 p.m. Engineering the Ohio Turnpike—Theodore J. Kauer, chief engineer, Ohio Turnpike Commission.

Detroit—April 19 and 27, May 3

April 19—Dinner Meeting and Plant Tour, Toledo, Ohio. Tour 3:00 p.m. to 4:45 p.m. Sun Oil Refinery, Toledo, Ohio. Reception 6:00 p.m., dinner 7:00 p.m. Commodore Perry Hotel. Fuels and Lubricants for 1960—Chas. L. Thomas, associate director of Research and Development Dept., Sun Oil Co. Toastmaster—J. E. Martin, president, Dana Corp. $5.00 per plate.

April 27—Great Lakes Steel Corp. Junior Group Plant Tour. 7:00 p.m. Junior members only.

May 3—Rackham Educational Memorial Building. Dinner 6:30 p.m., meeting 8:00 p.m. The Engineer and World Economics—F. C. Crawford, president, Thompson Products, Inc. Dinner Speaker—H. D. Ruel, general manager, Detroit Tigers. $2.75 per plate.

Indiana—April 8

Marott Hotel, Indianapolis, Ind. Dinner 7:00 p.m., meeting 8:00 p.m. Automotive Power—Gas Turbines or Piston Engines—M. M. Roensch, director of laboratory tests, Chevrolet Div., GMC, Detroit, Michigan.

Metropolitan—May 6

The Brass Rail, 43rd Street and Fifth Avenue, New York. Dinner 6:30 p.m., meeting 7:45 p.m. Fiberglas Truck Body Construction—H. Douglas and J. Lunn, Lunn Laminates, Inc. Cocktail Hour 5:30 p.m.

Mid-Michigan—May 8

Saginaw Country Club. Dinner 7:00 p.m., meeting 8:00 p.m. Fashion and Function in Automobile Styling—Willys P. Wagner, chief stylist, Commercial and International Design Section, Ford Motor Co. Dearborn, Mich. Ladies' Night.

Mohawk-Hudson—April 13

Panetta's, Broadway, Menands, N. Y. Dinner 6:45 p.m., meeting 8:00 p.m. Indianapolis 500 Mile Race—Robert T. Jackson, sales engineer, Perfect Circle Corp., Hagerstown, Ind. Color Slides.

Montreal—April 19

Sheraton Mount Royal, Montreal. Dinner 7:00 p.m., meeting 8:00 p.m. Diesel Engine Development in the United Kingdom—John McHugh, chief engineer, Leyland Motors (Canada) Ltd., Longueuil, Que., Canada.

New England—May 4

Faculty Club, M. I. T., 50 Memorial Drive, Cambridge, Mass. Dinner 6:45 p.m., meeting 8:00 p.m. Fairchild XC120 Pack Plane—Walter Tydon, chief engineer, Fairchild Aircraft Div., Hagerstown, Md.

Northern Calif.—April 28

Engineers' Club, San Francisco. Dinner 6:30 p.m., meeting 7:30 p.m. Latest Diesel Truck Development—The Diesel Racing Car—C. B. Foster, sales manager, Cummins Engine Co., Columbus, Ind.

Philadelphia—April 14

Engineers' Club. Dinner 6:30 p.m., meeting 7:45 p.m. Tires—M. E. Torrence, E. I. duPont de Nemours & Co.

Pittsburgh—April 27

Webster Hall and Mellon Institute. Dinner 6:00 p.m., meeting 8:00 p.m. Theory & Practice of Diesel Engine

SAE 5th Annual Earthmoving Industry Conference

April 13 and 14 — **Hotel Pere Marquette, Peoria, Illinois**

Technical sessions on both days will be devoted to subjects such as:

- **What Contractor Wants in Earthmoving Equipment**
- **Report on Vehicle Testing**
- **Earthmoving Engine Needs**
- **Front End Shovels**

Banquet on evening of April 13 will feature talk

"Progress at Its Best"

by Lt.-Gen. Eugene Reybold

Executive Vice-President and Secretary,
American Road Builders Association

Operation—H. M. Gadebusch, staff engineer, Detroit Diesel Eng. Div., GMC, Detroit, Michigan. Student Award Night.

St. Louis—April 13

Gatesworth Hotel, St. Louis. Dinner 7:00 p.m., meeting 7:45 p.m. Live Fire Power—L. L. Wilson, Ethyl Corp.

Salt Lake—April 19

Terrace Room, Newhouse Hotel. Meeting 8:00 p.m. Heavy Duty Loading Machines—Richard W. Walch, design engineer, Eimco Corp., Salt Lake City. Movie of Loading Machine cleaning open hearth furnace at Geneva Steel Co.

San Diego—May 11

1954 SAE President William Littlewood—Where Do We Fly From Here.

Southern Calif.—April 15 and 21. May 3, 4, 5, and 13

April 15—Rodger Young Auditorium. Dinner 6:30 p.m., meeting 8:00 p.m. Three Hands Cowboy—Julius Gaussoin, president of Silver Eagles Co., Portland, Oregon.

April 21—Field Trip arranged by Fred Christiansen to McCulloch Motors. Following tour there will be a question and answer period in the auditorium of McCulloch Motors.

May 3-4-5—General Petroleum Building, 6th & Flower Streets, Los Angeles, Calif. Seminar on The Effect of Sports Cars and Racing Cars on Passenger Car Design.

May 13—Rodger Young Auditorium. Dinner 6:30 p.m., meeting 8:00 p.m. Where Do We Fly From Here—1954 SAE President William Littlewood.

Texas Gulf Coast—May 12

Ye Olde College Inn, Houston. Dinner 6:00 p.m., meeting 7:30 p.m. American and European Cars—Today and Tomorrow—Mel Martin, feature columnist—Motorama, The Houston Post, Houston, Texas.

Western Michigan—April 20

Bill Sterns, Muskegon, Mich. Dinner 7:00 p.m., meeting 8:00 p.m. Marine Engines—Paul Engstrom, chief engineer, Gray Marine Motor Co., Detroit, Mich. Cocktails 6:30 p.m.

This is not a complete list of all Section Meetings. It includes only those meetings for which we have received sufficient advance notice to permit listing.

SAE National Meetings . . .

1954

June 6-11
Summer Meeting
The Ambassador,
Atlantic City, N. J.

August 16-18
National West Coast Meeting
Hotel Statler, Los Angeles, Calif.

September 13-16
National Tractor Meeting & Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 5-9
National Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

October 18-20
National Transportation Meeting
The Sheraton-Plaza
Boston, Mass.

October 26-27
National Diesel Engine Meeting
Hotel Statler, Cleveland, Ohio

November 4-5
National Fuels and Lubricants Meeting
The Mayo, Tulsa, Okla.

1955

January 10-14
Golden Anniversary Annual Meeting and Engineering Display
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

 

Myers DeMott

About SAE

RICHARD H. DeMOTT, chairman of the board and president of SKF Industries, Inc., Philadelphia, and **JAMES L. MYERS**, chairman of the board and president of Clevite Corp., Cleveland, received the Stevens Honor Award February 26. This award is given annually by Stevens Institute of Technology for "notable achievement." Both DeMott and Myers are leaders in the bearing industry and graduates of Stevens.

ROBERT E. WILKIN, vice-president and general sales manager, has announced the formation of a plastics sales group by Hooker Electrochemical Co., Niagara Falls. This group will handle sales of Hooker's new fire-resistant polyester resin named "Hetron."

ROBERT T. HOLLAND has been named sales manager of General Electric Co.'s aircraft accessory turbine department. In his new assignment, Holland will be responsible for the sale of turbine-driven accessories for aircraft, including turbo hydraulic pumps, turbo-alternator drives, self-contained jet engine turbostarters, turbo-fuel pumps for jet engine afterburners and aircraft turbosuperchargers. Prior to his present appointment, Holland was engaged in special assignments for the aircraft accessory turbine department.

 

Holland Roth

CARL F. B. ROTH, president of Aircooled Motors, Inc., Syracuse, N. Y., has been elected president of the manufacturers Association of Syracuse for 1954 and 1955.

ALBERT L. HESS has become service manager for the Charles W. Carter Co., Los Angeles. Hess was with Autocar Sales and Service Co. in Los Angeles as a service manager.

ALEXANDER KARTVELI has been appointed to the Committee on Aerodynamics, National Advisory Committee for Aeronautics. He is vice-president and chief engineer of Republic Aviation Corp., Farmingdale, N. Y.

DR. WILLIAM J. O'DONNELL, chief development engineer, Republic Aviation, Farmingdale, N. Y., has been appointed to the Committee on Aerodynamics, NACA, and reappointed chairman of the Subcommittee on Internal Flow. He is also reappointed to the Subcommittee on Engine Performance and Operation.

WILLIAM I. STIEGLITZ, who is design safety engineer for Republic Aviation, has been reappointed to the Committee on Operating Problems and to the Subcommittee on Aircraft Fire Prevention, NACA.

JOHN T. PANKS is managing director of Rootes Motors, Inc., New York. Panks was formerly managing director of Rootes Motors, Ltd., Scarboro, Ontario, Canada.

MORTON JACOBSON is senior project engineer in the Gas Turbine Division of the Allison Division of GMC, at Indianapolis. Jacobson was project engineer for ACF-Brill Motors, Philadelphia.

ROBERT GOLD, previously project engineer at the Saginaw Steering Gear Division, GMC, is now chief engineer for Dayton Rogers Corp., Minneapolis.

NEIL V. HAKALA has been appointed assistant director in the Esso laboratories, Standard Oil Development Co., central research and engineering affiliate of the Standard Oil Co., New Jersey. He was a section head at the Research Division of the company which is in Linden, N. J.

GEORGE C. CAMPBELL is now a sales engineer with the Gemmer Mfg. Co., Detroit. Campbell was previously a project engineer for Federal-Mogul Corp., Detroit.

JOHN W. JUPPENLATZ has announced the opening of the Quaker Alloy Casting Co., located at Myerstown, Pa., for the purpose of producing small carbon, low alloy, stainless and high alloy castings. Production of castings is expected about the first of this month. Juppenlatz is secretary-treasurer of the company. He is also a member of SAE's Iron and Steel Technical Committee's Panel B-Castings, and chairman of ISTC's Division XXI—Heat & Corrosion Resistant Alloy Castings.

ARTHUR TOWNHILL is associate project director for the Alloy Engineering & Casting Co., Champaign, Ill. He will direct process engineering and production activities on light metal castings. Townhill was with Thompson Products, Cleveland, as manager of the Light Metals Division. He was chairman of the Cleveland Section in 1941. He has also been membership vice-chairman of the Production Activity.

 

Townhill Eckert

JOHN C. ECKERT is now sales engineer for The Palnut Co., Detroit. Eckert was with Ford Motor Co., Dearborn, Mich., as quality control technician.

JAMES K. FULKS, executive vice-president of Ex-Cell-O Corp., has been elected a director of Miller Mfg. Co.

WILLIAM K. NORWICK, executive assistant to the chief engineer, Fisher Body Division, GMC, Detroit, has been elected vice-president of the American Society of Body Engineers.

Members . . .

GLIDDEN S. DOMAN, president of Doman Helicopters, Inc., Danbury, Conn., has announced that though the company has been developed as a privately owned venture, it is now entering the Government financed research-development field. Doman reported that the company's progress, especially the excellent performance of Army YH-31's has gained entry to the Government R & D field for the company. Doman plans manufacture in Canada for the commercial field and stated that such action will also bring about production orders from the U. S. Government.

WILLIAM H. DuBOIS has been appointed chief engineer for lining development at the Bendix Products Division, Bendix Aviation Corp. He was chief engineer of the aircraft wheel and brake operation at Bendix.


DuBois


Ketchum

LEE KETCHUM has organized his own business as a manufacturing agent on fleet items in Seattle. He was sales manager for Everett Truck Sales, Everett, Wash. Ketchum was the 1944–45 chairman of SAE's Northwest Section.

RICHARD C. CARSON has been appointed vice-president in charge of engineering, Shuler Axle Co., subsidiary of Fuller Mfg. Co. in Louisville, Ky. He was sales manager for the company.

MIGUEL ORDORICA is now chief engineer, chassis and military, Willys Motors, Inc., Toledo. Ordorica was previously special assistant to the chief engineer for Willys.

LEO F. DONNELLY is now a project engineer in the truck experimental section of the Ford Motor Co. Formerly, Donnelly was senior test engineer in the Experimental Division of the Mack Mfg. Corp., Allentown, Pa.

FRANK A. KOTTMEIER has become a special representative for Caterpillar Tractor Co., Peoria, Ill. He was formerly supervisor, sales training, for Caterpillar.

WILLIAM W. HIGGINBOTHAM is now with the U. S. Government, Ordnance Climatic Test Detachment, at the Yuma Test Station, Yuma, Arizona. He is chief of the Automotive Division. Higginbotham was previously resident engineer for the Southwest Research Institute, San Antonio.

GORDON J. MASON is now a field engineer for Caterpillar Tractor Co., Peoria, Ill. He was previously in training at Caterpillar.

LEVI C. MOCK is with the traffic department of International Harvester Co., Chicago, as a supervisor of carload routing. He was a supervisor of Drive-Aways, International Harvester Co.

THEODORE R. BATTEMA is chief engineer for the Western Design and Mfg. Corp., Goleta, Calif. Battema was senior engineer for Western.

DALE A. CUE has joined the A. O. Smith Corp., Milwaukee, as a quality control engineer. He is on the central quality control staff. Cue was previously with the International Harvester Co. in Indianapolis, as a quality control analyst.

KENNETH R. ALLEN is now a process engineer for the Plax Corp., West Hartford, Conn. He was with Caterpillar Tractor Co., Peoria, Ill., as a design engineer.

ROBERT E. CARBAUH is manager of the fire detector section of the American Machine & Foundry Co., Boston. Carbauh was president and general manager, Petcar Research Corp., Belleville, N. J.

K. G. MACKENZIE has retired as assistant to the vice-president in charge of the refining department of The Texas Co. He plans to open offices as a private petroleum consultant at Old Hill Farms Road, Westport, Conn. Mackenzie has been with Texaco for more than 42 years.


Mackenzie


Curtice

HARLOW H. CURTICE, president of General Motors Corp., Detroit, was chairman of the business group at the White House Conference on Highway Safety held in Washington, D. C., February 17 to 19.

HERBERT CLARK has taken over the position of managing director of Clifford Aero & Auto Ltd., Birmingham, England. Clark was formerly general manager of the engines branch, Morris Motors, Ltd., Coventry, England.

HERBERT JAMES WARD has accepted a position as associate research engineer for the Boeing Airplane Co., Seattle Division. He was with Potlatch Forests, Inc., Lewiston, Idaho.

HUGO H. HASS, civilian head engineer of the internal combustion engine section, U. S. Navy, is retiring after 34 years service in the Defense Department. He has been associated with diesel engines for 48 years throughout Europe, and the USA. He will open his own consulting service in all phases for marine and stationary powerplants in Washington, D. C.


Haas


Sereno

CHARLES A. SERENO has been elected vice-president and general sales manager of the Electronic and Mechanical Products Divisions, by the board of directors of Air Associates, Inc., Teterboro, N. J. Sereno was chief engineer.

Men in Uniform

CHARLES C. (CHUCK) DYBVIG, resident engineer, Firestone Tire & Rubber Co., Detroit, is shown with his three boys: Alan, 14, Explorer Scouts; Dick, 12, Regular Boy Scouts; Ned, 9, Cub Scouts. (Troop B5, Birmingham, Mich.) Dybvig is chairman of the Troop Committee.

This picture appeared in the Birmingham Eccentric last February in connection with Boy Scout Week, February 8-12, since it is considered unusual for a family to have a leader in scouting and a boy in the three branches.

Dybvig is chairman of SAE's Detroit Section Membership Committee and very active in the Section.

SAE Member Becomes a Judge

WILLETT J. McCORTNEY (extreme left), engineer in charge of rubber and plastics development at Chrysler, was a judge at the Associated Terrier Clubs Show held in New York last February. He is chairman of the SAE Nonmetallic Materials Committee. Judge McCortney is shown with the dog chosen best white bull terrier at the show.

STUART A. WOODWARD, formerly field engineer for the American Bosch Corp., Springfield, Mass., is now sales engineer for Waukesha Motor Co., Waukesha, Wis.

FRANK N. ADGATE, previously section supervisor, product engineering, for the Ford Aircraft Engine Division, Chicago, is now with the Allison Division, GMC, Indianapolis. He is a welding engineer, experimental process engineering.

EARL GLENWOOD BOUDREAU is supervisor of the production contact section, product engineering department, for Ford Motor Co.'s Automatic Transmission Division, Livonia, Mich. Boudreau was resident engineer.

HARRY SCOTT, previously project engineer at the Saginaw Steering Gear Division, GMC, is now sales engineer for Pesco Products, Division of Borg-Warner, Bedford, Ohio.

J. A. SHANK, has announced that the Service Division of the Electric Auto-Lite Co., Toledo, Ohio, has launched a long-range educational program to give distributor salesmen a better understanding of automotive electrical parts. Shank is manager of the division. The first phase of the program, according to Shank, made its debut at the Automotive Electrical Association convention in Chicago in February. A slide film featuring the construction and operation of contact sets and condensers was shown to Auto-Lite central distributors.

Shank has been re-elected to a two-year term on the board of directors of the AEA. He has served on the board for approximately 25 years.

WALTER G. PREVOST has become associate engineer for Boeing Airplane Co., Seattle. He was with the J. Scott Gassaway Co., Los Angeles, as a design engineer.

EARL C. THAYER, formerly with the J. I. Case Co. of Racine, Wis., is now employed in the field of product design for the Kiekhaefer Corp., Cedarburg, Wis.

ROBERT E. DAY, staff engineer at Solar Aircraft Co., San Diego, discussed "Shell Mold Stainless Castings of Aircraft Quality" at a meeting of the San Diego Section of the American Society of Mechanical Engineers, February 26.

ALTON B. CRAMPTON has been appointed a member of the Subcommittee on Lubrication and Wear, National Advisory Committee for Aeronautics. Crampton is head of the aviation fuels and lubricants research section in the Esso laboratories of the Standard Oil Development Co.

LEWIS R. CATT is a sales engineer for the Baker Raulang Co., Cleveland. He was technical advisor for material handling equipment, Department of the Navy, Bureau of Supplies & Accounts, Washington, D. C.

J. RICHARD ANDERSON is president of the Columbus Oil Co., Columbus, Ohio. Anderson was vice-president of Hall Distributor Corp. in Columbus.

HUBERT M. CLARK is with Rayette, Inc., Missouri Division, as production manager, defense. Clark was vice-president of Eastern-Michigan Industrial Sales Co., Detroit.

EDWARD A. KUBICEK, formerly design engineer for Allis Chalmers Mfg. Co., Milwaukee, is now with The Heil Co. in Milwaukee as a tooling design engineer.

ROBERT F. DUNCAN has been made manager of the Package Products Division of Calumet Refining Co. in Chicago. He continues in the capacity of secretary and treasurer and a member of the board of directors.

ARTHUR P. McCABE is a chief aerodynamicist at the White Sands Proving Ground, Las Cruces, New Mexico. McCabe was previously a research engineer at M.I.T.

ROBERT J. SULLIVAN is supervising engineer at Caterpillar Tractor Co.'s Arizona Proving Ground in Phoenix. Sullivan was previously supervising engineer at the Peoria, Ill., Proving Ground for Caterpillar.

FREDERICK C. HENDY, formerly design engineer for Cushman Motor Works, Lincoln, Nebraska, is president of the Aspen Water Co., Aspen, Colorado.

TOSHIYUKI FUKUSHIMA is a stress engineer for Prewitt Aircraft Co., Clifton Heights, Pa. Previously he was with Ultra-Mechanisma, Inc., Cambridge, Mass.

ARTHUR F. OCHTMAN is manager of engineering, Engine Division, for The Buda Co., Division of Allis-Chalmers Mfg. Corp., Harvey, Ill. Ochtman was formerly general service manager for Buda.

V. P. RUMELY, vice-president in charge of manufacturing for the Crane Co. in Chicago, tells us that the new Crane titanium plant in Chattanooga, for which he was pictured breaking ground on page 74 of the February, 1954 Journal, is scheduled for completion January 1, 1956, rather than July 1, 1955, as stated in the item.

LAWLER B. REEVES has been named special assistant to the president of the United States Rubber Co., New York. Reeves was formerly manager of oil marketer sales for the Tire Division of the company.

D. R. LOCKWOOD, safety engineer, Standard Oil Co. of California, and **J. W. SINCLAIR**, manager, auto department, Union Oil Co. of Calif., are on the newly formed West Coast Subcommittee of the Highway Safety Committee of the Private Truck Council of America. The Council's Highway Safety Committee is responsible for the "Driver's Handbook and Safety Manual for Commercial Truck Operators" and the "Systematized Fleet Safety Program."

LOWELL E. HAAS has joined Scott-Atwater Mfg. Co., Minneapolis, as a liaison engineer. Haas was a resident engineer at the Maquoketa, Iowa, plant of the Clinton Machine Co.

Larrick

BENSON M. LARRICK, vice-president and general manager of the Twin City Rapid Transit Co., Minneapolis, has been elected to the board of directors of the company. Larrick joined the company two years ago to supervise the conversion from streetcars to buses. Before coming to Minneapolis, he converted streetcar operations to buses in Tampa and Jacksonville, Fla., Mobile, Ala.; Tulsa, Okla., El Paso, Texas, and most recently the extensive Los Angeles Transit system.

WADE O. HEMPHILL is a machine designer with the Corning Glass Works, in the machine development department of the Engineering Division. He was formerly a draftsman, Lycoming Division, Avco Mfg. Corp., Williamsport, Pa.

J. DEAN GARRETT has been promoted by Thompson Products, Inc. of Cleveland to the position of district sales manager, Chicago office. He was formerly sales engineer.

KENNETH I. ROBINSON, previously an engineer for the Electric Auto-Lite Co., Toledo, is now a project engineer with the Johnson Motor Co. at Waukegan, Ill.

J. E. HEUSER, Engine Division sales manager of the Le Roi Co., subsidiary of the Westinghouse Air Brake Co., of Milwaukee, was elected president of the Internal Combustion Engine Institute at the annual meeting in February. **B. G. VanZEE**, chief engineer, Minneapolis-Moline Co., Minneapolis, was elected vice-president.

Heuser

Brown

ARTHUR S. BROWN has joined the design staff of the Chevrolet central office, truck and passenger car engineering department. Previously, he was an engineer in the Hudson Motor experimental chassis engineering department.

JOHN W. HORTON is plant manager for Perkin Engineering Corp., El Segundo, Calif. Horton was previously chief of the product development department, Heyer Industries, Inc., Belleville, N. J.

MICHAEL J. McINERNEY is senior engineer for Cook Research Laboratory, Skokie, Ill. McInerney was a test engineer for the Aeroproducts Division of GMC, Dayton, Ohio.

JAY W. KREUSSER is district sales manager for the Pontiac Motor Division, GMC, in central and southeastern Ohio. Kreusser was coordinator of quality for Kaiser Motors Corp., Willow Run, Mich.

ROBERT D. BEATTY, JR. has been appointed as a sales engineer for the Parker Appliance Co., Cleveland, Ohio, in the Alabama-Florida territory. Beatty joins Parker with more than 13 years experience in sales and engineering work in the South. Upon completion of an intensive training course at the home plant, Beatty was assigned to serve industry in the Alabama-Florida territory with Parker's line of products for industrial machines and processes.

BERNARD LAST is now chief engineer for Rockwell Meters, Inc., Uniontown, Pa. He was a project engineer, lubrication accessories, Rockwell Mfg. Co., Pittsburgh, Pa.

DONALD P. ALLEN is now doing work in vibration research with the Remler Co. of San Francisco.

SAE Fathers and Sons . . .

C. F. (RED) STERBUTZEL and his son, **JAMES** are shown at a recent meeting of the Pittsburgh Section. Red has been operating a tire service business in Connellsville, Pa., for the last 24 years. The automobile still provides the bulk of his business, but in more recent years tires for heavy off-the-road construction and maintenance equipment, as well as for coal mine shuttle cars, are providing a greater portion of his business.
Red's son, Jim, is an SAE student member at General Motors Institute, Flint, Mich. He is in his first year.

FRANK A. TIEDGE is now zone manager, Dodge Truck Division of Chrysler, Detroit. He was regional truck manager for the company in Philadelphia.

THOMAS HARDGROVE is now with the Aerojet-General Corp. in Azusa, Calif. He was formerly head of the plant engineering department, California State Polytechnic College, San Luis Obispo, Calif.

H. C. WALTERS has announced the change of name of the Scintilla Magneto Division to the Scintilla Division, Bendix Aviation Corp., Sidney, N. Y. Walters is chief engineer of the division.

GLENN W. JOHNSON, supervisor, producer relations, motor transportation, Bowman Dairy Co., Chicago, has been elected vice-chairman of the Illinois Conference of the National Highway Users Conference.

EVERETT G. FAHLMAN, president of the Permold Co. of Medina, Ohio, has been designated representative for the Foundry Division on the board of directors of the Aluminum Association. Fahlman recently returned to his company after serving as deputy director of the Aluminum and Magnesium Division, Business & Defense Services Administration, Department of Commerce. He was on loan to the government under a rotation system, by which industry makes available the services of experienced personnel for short periods of time.

ERIC SCHWARZ is now employed at the International Division of A. O. Smith Corp., Milwaukee. Formerly, Schwarz was with the Bechtel Corp., New York, as administrative engineer.

SIMON D. DEN UYL, president of Bohn Aluminum & Brass Corp., Detroit, has been re-elected to serve the Aluminum Association as a vice-president.

CARL F. BAKER, has been appointed to the new top management position of quality manager at the Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn.

The appointment is part of a major reorganization of the division's engineering department designed to give increased emphasis to quality control of its products and realign the department's development functions. **THOMAS B. RHINES,** assistant chief engineer at Hamilton has taken over the duties of Baker and is handling problems of older and more established products. **ERLE MARTIN,** general manager, said, "these moves are designed to satisfy the customer's requirement for a good design of high quality which is economically produced on schedule. The new quality control department will be looking into the factors that influence virtually all our work from engineering to the finished product."

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A committee made up entirely of SAE members, with one exception, is working on the University of Michigan's project for an automotive teaching laboratory. They are: **WILLIAM H. GRAVES,** vice-president in charge of engineering for Packard; **C. L. McCUEN,** vice-president of GMC's research laboratories; **GEORGE W. MASON,** chairman and president of Nash-Kelvinator and president of the Automobile Manufacturers Association; **EARLE S. MacPHERSON,** vice-president of engineering for Ford Motor Co.; **JAMES C. ZEDER,** vice-president and director of engineering and research for Chrysler; and **CARL T. DOMAN,** manager of Ford's service department.

The purpose of the program is to ease the shortage of trained engineers in industry. The cost has been estimated at $10,000,000.

Obituaries

H. H. BUDDS

H. H. Budds, 50, president of Aero Castings, Inc., Canaan, Conn., died February 18.

Budds had a great deal of managerial experience in industry. He began his career as general foreman in charge of the body frame and panel department, Hayes Mfg. Co., Detroit. He was later general foreman in charge of the stamping division of the experimental department, Michigan Stamping Co., Detroit.

At the Briggs Mfg. Co., also in Detroit, Budds was general manager of the Aircraft Division, and was in full charge of all operations. This was 18 years after he had joined the company as foreman of the small parts department. In the intervening time he had moved to superintendent in charge of the Sheet Metal Assembly Division, general superintendent of the same division, assistant factory manager, and then manufacturing manager for Briggs Motor Bodies in Dagenham, England. In 1941 he went with Ranger Aircraft Engines, Farmingdale, N. Y., where he was in charge of all operations.

Budds was born in Pana, Ill., and was graduated from Pana High School. He was a member of the Institution of Production Engineer, London, England, and the Institute of Aeronautical Sciences, as well as SAE.

A. LUDLOW CLAYDEN

A. Ludlow Clayden, long a familiar figure in the SAE, died in Florida, February 23. He was 71. Clayden had been in retirement since July, 1953, and spent most of the intervening time at Daytona Beach "sitting in the sun," as he would have put it.

Born in Bath, England, and educated at Bristol University, Clayden was one of those fortunate individuals who was able to follow the development of the automotive industry from its earliest days. He started out with a garage and repair shop when motoring was largely a sport and road racing was the measure of progress. He later was associated with the Daimler Motor Co. in Europe and the Wright-Martin Aircraft Co. For many years, he was active in the editorial field with various trade publications.

After coming to this country, Clayden served as consultant to the United States Cartridge Co. He joined the Sun Oil Co. in 1922 as chief automotive engineer and was with Sun 31 years, serving in many capacities. His most recent position was manager of the automotive research laboratory.

His many friends in the petroleum and automotive industries will remember him as an active SAE member. He served in numerous activities, including vice-president of the 1934 Fuels and Lubricants Activity. He was also active in the Coordinating Research Council, the American Petroleum Institute, the American Society for Testing Materials, as well as various other industry organizations.

JAMES FOSTER AUSTIN

James Foster Austin, 50, regional manager of Engine Life Products Corp., died at his home February 27.

Austin was a native of North Kingsville, Ohio. He received his education at the John Marshall Law School, Cleveland, and Ohio State in Columbus.

He first entered industry with the New York Central Railroad. Later he joined the Porter Lavgtry Publishing Co. doing sales work on trade papers. His further experience was with E. I. Dupont, Sherwin-Williams, the Orco Co., and Deluxe Products Corp. At Deluxe he was service and sales engineer.

Besides SAE, he was a member of the Hella Temple, and the Dallas Commandery.

He is survived by his wife, son, four brothers, two sisters, and a grandson.

WILLARD A. STEARNS

Willard A. Stearns, 54, died from a heart attack on December 11, 1953. Stearns was branch manager of the Detroit office of Graton & Knight Co., Worcester, Mass.

Stearns joined Graton & Knight in 1944 as sales engineer, district representative and branch manager. His previous experience was with the Dupont Cellophane Division of H. D Catty Corp. where he was Western distributing manager. Prior to that he was with Packard Motor Co., and the Buick Division of GMC.

A native of Michigan, he received the B.S. degree in mechanical engineering from the University of Michigan.

Stearns, whose specialty was oil seals, synthetic rubber seals and packings, was at one time a member of SAE's Oil Seal Committee.

A. F. OLSEN

A. F. Olsen, lubrication engineer for the Union Oil Co. of California, Portland, Oregon, died October 26 after a brief illness. He was 56.

Olsen was with the Union Oil Co. of California for almost a quarter of a century and held various positions in the operating and sales department. His latest assignment included surveying mills and plants for proper lubricants, assisting sales personnel in handling lubricant problems and recommendations.

Previously he had been chief engineer for the Columbia Willamette River Towing Co. in Portland, Oregon, the Columbia Digger Co. in Portland, and the America Transportation Co., also in Portland. Prior to that he was first assistant engineer for the Harkins Transportation Co., Portland, and the Columbia Towing Co., Ranier, Oregon.

Besides the SAE, Olsen held membership in the Petroleum Educational Institute. He also served in the U. S. Army during World War I.

HAROLD F. HOWARD

Harold F. Howard, assistant group executive at Ford Motor Co.'s Aircraft Engineering Division in Chicago, died January 7. He was 57.

Prior to joining Ford, Howard was president of the Harold F. Howard Co., management consultants and engineers, located in Detroit. He had also been a vice-president of the Fruehauf Trailer Co. in Detroit, general manager of GMC's Chevrolet Division in Flint, manager of the San Francisco and New York branches of Wire Wheel Corp. of America, and engineering consultant for various other companies.

Howard studied technical subjects at the University of Buffalo, business administration at the University of California, and banking and foreign exchange at Columbia. He was born at Corry, Pa.

WALTER H. KETEL, formerly manager of the Denver branch of Trailmobile, Inc., Cincinnati, is now branch manager for the company in Chicago.

EDWIN J. MURRAY is now employed as an engineer by the Speed Control Division of Fairchild Engine & Airplane Co., Wickliffe, Ohio. He was formerly with the Parker Appliance Co. of Cleveland.

JOHN R. HOLLOWELL, who has been with Ford since 1946 is now advanced projects engineer, product engineering department of the Special Product Division of Ford. He was design section supervisor of the Automatic Transmission Division.

ANDREW T. BROWNE has become chief engineer for O. E. Szekely & Associates, Inc., Philadelphia. Browne was previously assistant chief engineer at ACF-Brill Motors in Philadelphia. He is chairman of Membership and Reception for the Philadelphia Section.

JOSEPH F. BIRD, previously project engineer at the Aircraft Division of Packard Motor Co., Detroit, is now test engineer for Ford Motor Co., Automatic Transmission Division, Livonia, Mich.

HAROLD W. JOHNSON, formerly with Kaiser Motors, Willow Run, Mich., as chief chassis engineer, is now chassis engineer for Ford Motor Co., product engineering department of the Special Product Division.

ARNOLD J. TENNER, formerly mechanical engineer with the U. S. Army, is production liaison engineer for the Revere Corp. of America, Wallingford, Conn.

CHRISTOPHER C. RACHAL, JR. is with the Temco Aircraft Corp., Dallas, as an engineering designer "B". He was an engineering draftsman for McDonnell Aircraft Corp., St. Louis.

GERALD M. LEFOLEY is a designer for Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn. He was formerly a designer for Boeing Airplane Co. in Wichita, Kansas.

LOUIS B. FELDMAN has joined the Post Office Department, Office of the Chief Industrial Engineer, Washington, D. C. He is an automotive industrial engineer. Feldman was previously supervisor of automotive engineering for the Department of the Army, Transportation Research & Development Station, Fort Eustis, Va.

DAVID H. C. HOH is research engineer for the Chain Belt Co., Milwaukee. Hoh was experimental engineer for the Harley Davidson Motor Co., Milwaukee.

IGOR KAMLUKIN, formerly project

engineer on farm tractors and power units for Allis Chalmers Mfg. Co., Milwaukee, is now director of engineering for Simplicity Mfg. Co., Port Washington, Wis. Kamlukin is secretary of the Milwaukee Section.

WILLARD O. BURGOON has become sales engineer for The E. V. Larson Co., Ltd., Toronto, Ontario, Canada. He was previously manager of development, Aircraft Wheel & Brake Division, Goodyear Tire & Rubber Co. of Canada in New Toronto, Ontario.

MILTON A. PHILLIPS is now assistant sales manager for the Industrial Division of the Warner Lewis Co., Division of Fram Corp., Tulsa, Okla. Phillips was industrial district manager for Fram.

RALPH E. OWENS has joined the Southern Pacific Railroad, Salt Lake Division, Sparks, Nevada, as heavy duty mechanic. He was previously heavy duty mechanic for Aerojet-General Corp., Azusa, Calif.

LLOYD W. SCHUHMANN has become assistant chief inspector for the Cameron Iron Works, Inc., Forge & Ordnance Division, Houston. He was formerly with the Tank Engine Division of Chrysler Corp., as divisional superintendent of steel machining.

DR. DONALD S. McARTHUR addressed members of the Central Jersey Chapter of the American Statistical Association at Princeton University March, 15. His paper was, "Evaluation of Test Procedure in Industry." Dr. McArthur is chemical engineer for Standard Oil Development Co., Research Division, Linden, N. J.

JOHN H. DANNAN has joined Hydro-Aire, Inc., Burbank, Calif., as chief project engineer. Dannan was formerly chief designer for the Stratos Division of Fairchild Engine and Airplane Corp., Bay Shore, N. Y.

EARL AIKIN is now president of Aikin-McCracken, Ltd., an advertising agency, in Toronto, Ontario, Canada. Aikin was previously vice-president of the same company.

TODD W. FREDERICKS, who was formerly executive engineer at the Bohn Aluminum & Brass Corp. in Detroit, is now with Aluminum Industries, Inc. also in Detroit. Fredericks is district manager and is located at the New Center Building in Detroit.

ALBERT J. BLACKWOOD has been reappointed to the Subcommittee on Aircraft fuels, NACA. He is assistant

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director, Standard Oil Development Co., Research Division, Linden, N. J.

MILANKO IKACH has joined the Allison Division of General Motors, Indianapolis, as a detail engineer. He was formerly a layout draftsman for the Timken Detroit Axle Co. in Detroit.

ROY BEMISS LIGGETT has joined the Palmer Equipment Corp. in Louisville, Ky., as vice-president. Palmer Equipment is a new corporation just getting set to produce heavy-duty axles and brakes. Liggett was vice-president and chief engineer for Shuler Axle Co. in Louisville.

H. LOUIS, who has been engineering superintendent for Fleet Mfg. Ltd., Fort Erie, Ontario, Canada, is now chief engineer with responsibility for quality control as well as engineering functions for the company.

ARTHUR C. BUTLER, director of the National Highway Users Conference, has announced the Fifth Highway Transportation Congress to be held in Washington next May 4, 5, and 6. Sessions will be held in the Mayflower Hotel. The purpose of these biennial congresses is to consolidate by open discussion, the ideas of all who are concerned with the welfare of over-the-road transportation, and to reach a common purpose in finding solutions to the problems in the field confronting the nation.

GORAN NORDFORS, previously with Bolinders Fabriksaktiebolag at Kallhall, Sweden, is now with Juselius Fabriker AB, Abo, Finland.

CHARLES E. HIRSCH, who was previously a technical engineer for the aircraft nuclear propulsion department, General Electric Co., Cincinnati, is now project liaison specialist at GE's small aircraft engine department in Lynn, Mass. Hirsch is liaison between manufacturing and the project group in the design and development of a small aircraft gas turbine.

S. P. HORE, who has been executive engineer at the Maithon project of Damodar Valley Corp. and was in charge of maintenance, repair and erection of construction and earth-moving equipment required for the Maithon Dam in India, has joined the Madras Institute of Technology as head of the department of automobile engineering.

DR. GUSTAV EGLOFF, director of research for Universal Oil Products Co., Des Plaines, Ill., will receive the 1954 Carl-Engler-Medaille, Germany's

highest award in the field of mineral oil science. Dr. Egloff is the first scientist living outside of Germany to receive the award. The medal will be given in October during the annual congress of the German Institute of Petroleum and Coal to be held in Essen, West Germany. He will address the congress on "Chemistry in the Modern Oil Industry."

KENNETH I. ROBINSON is supervisor of testing for Johnson Motors, Waukegan, Ill. Robinson's job is to supervise experimental testing on outboard motors. He was formerly project engineer for the Electric Auto-Lite Co. in Toledo.

JOSEPH TALBOTT has become assistant sales manager for the Sealed Power Corp. of Muskegon, Mich. Talbott, who is now in charge of the Detroit office which handles all contacts to accounts in the Detroit territory, was formerly sales engineer for Sealed Power.

FRANK W. ZURN is assistant sales manager for the American Flexible Coupling Co., Erie, Pa., an affiliate of J. A. Zurn Mfg. Co. The company produces flexible couplings and specialized power transmission equipment as used in the connection of rotating machinery. Zurn was previously doing engineering-sales work for the company.

WILFRED JAMES CHENERY is with the International Harvester Co., Hamilton, Ontario, Canada, as sales engineering consultant. Chenery was formerly service supervisor for the same organization in Toronto.

JAMES RAYMOND DAVIS is engineer for Fairbanks Morse & Co. in Beloit, Wis., producers of diesel engines, locomotives, pumps, electric motors, etc. Davis was previously serving with the U. S. Navy as a lieutenant.

RALPH A. NELSON has joined The Thermoid Co. of Trenton, N. J., as a sales engineer, OEM Division, in the Chicago area. He was formerly connected with The S. K. Wellman Co. of Bedford, Ohio, as a sales representative.

E. VAN VECHTEN, formerly with the Purchasing Division of Southwest Steel Rolling Mills as director of purchases and stores, is now sales manager for Keystone Engineering Co., Los Angeles.

LeROY GERALD SMITH is now Pacific North West Division engineer for the Ensign Carburetor Co., Huntington Park, Calif. Smith previously

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About SAE Members
continued

was South West Division engineer for Ensign. His duties entail developing the use of gas and liquefied petroleum gas as a motor fuel for stationary and mobile engines in trucks, tractors and powerplants. He is also establishing dealer and sales outlets for the company, besides training personnel in the use and installation of equipment for manufacturers of gas and LP Gas equipped units.

LORNE FREDERICK NEDVIDEK has become the Florida district manager for Toledo Steel Products Co., Toledo. Formerly fleet service engineer for the same company in Toledo, Nedvidek is now located at Jacksonville, Florida. His district includes Southern Georgia.

WALDON RICE RHOADS has joined the Georgia Division of Lockheed Aircraft Corp., Marietta. He is in charge of the direction of activities of a group of operations research scientists engaged in analyzing and evaluating military airborne weapons and transport systems. Rhoads has had SAE membership in the St. Louis, Southern California, Metropolitan, and Washington Sections.

JULIUS R. KOPPELMAN is now with the Ryan Aeronautical Co. in San Diego as an engineering designer "B". Koppelman was with the Sandia Corp., Sandia Base, Albuquerque, New Mexico, as a design draftsman.

ROBERT C. LANDESMAN is project engineer in the production engineering department of the Allison Division, GMC, Indianapolis. He is engineering contact between production, inspection, and project engineering groups. Landesman was formerly with the Studebaker Corp. at South Bend as an engineering assistant.

ANDREW C. McDERMOTT is a stress analyst for the Machine and Tool Design Co. in Baltimore. He was previously with Kish Engineering, Inc., Kalamazoo, Mich., as a stress analyst.

STEVE S. HURITE, previously project engineer at the Fisher Body Division of GMC in Detroit, has now been transferred to Fisher's body aircraft plant #2 at Grand Rapids.

Students Enter Industry

WALTER J. KLINE (Oklahoma A & M '53) is a junior process engineer for Corning Glass Works, Muskogee, Okla.

ROBERT W. WATKINS (A & M College of Texas '54) has become a junior engineer for Chance Vought Aircraft, Dallas.

WILLIAM C. SCOTT (The Pennsylvania State University '53), with the General Electric Co., Lynn, Mass., is in training on the test engineering program at GE.

JOHN EDGAR AHLBRAND (Purdue University '54) is a sales engineer trainee for the Cummins Engine Co., Inc., Columbus, Indiana. Ahlbrand worked with the company previously in the product engineering department as senior draftsman.

DAVID S. VAUGHAN (Case Institute of Technology '53) is project engineer for Paragon Gear Works, producers of marine transmissions, Taunton, Mass.

HAROLD EDWARDS, JR. (Parks College of Aeronautical Technology '53) is with the Boeing Airplane Co. in Wichita, Kansas, as a junior engineer "B". He is with the liaison engineering group, B-47 project.

ROBERT H. PETERSON (Parks College of Aeronautical Technology '53) has joined Boeing Airplane Co. in Seattle as an engineer.

LEE ALLEN DeBOER (Bradley University '54) is a junior engineer in the powerplant testing section of North American Aviation, Inc., Columbus, Ohio.

LOWELL M. SCHMIDT (University of Wisconsin '53) is now experimental engineer for the Waukesha Motor Co., Waukesha, Wis.

CARLTON F. GRANTHEN (Michigan State '53) is a college graduate trainee with the Detroit Transmission Division of GMC, Willow Run, Mich.

KENNETH L. WHEELER (Detroit Institute of Technology '53) has joined the Burroughs Corp., Plymouth, Mich., as an electrical design engineer.

RICHARD A. HARSTRICK (Academy of Aeronautics '53) is a mechanics helper for Colonial Airlines at LaGuardia Airport, Flushing, L. I.

KALMAN SHMUELI (University of Miami '54) is now working as a mechanical engineer in the Mechanical Evaluation Division of the Naval Ordnance Laboratory at Silver Springs, Md.

Rectifier Locomotive Scores Well in Service

Based on paper by

E. W. AMES

Westinghouse Electric Corp.

IGNITRON rectifier locomotives and diesel locomotives employ identical traction motors which can be interchanged, but differ in all other respects. The traction motors of a diesel locomotive receive power from a diesel-driven generator. The maximum horsepower available is limited by the diesel and is essentially constant. The rectifier locomotive, on the other hand, gets its power from a substation via overhead lines, and the horsepower limit is reached when electrical equipment becomes too hot or the drivers slip.

Present rectifier locomotives rate 3000 hp per cab, or 6000 hp for two units, with short time ratings in excess of 8500 hp. Tests on motor and apparatus indicate a doubling of power in the near future.

Rectifier type locomotives open the way for hauling heavy loads at high speed and for the use of 60-cycle instead of 25-cycle power, thereby reducing the cost of electrification and giving better service. (Paper "The Ignitron Rectifier Locomotive" was presented at SAE Williamsport Group Meeting, Feb. 25, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Can a Wheel Replace a Track?

Based on paper by

LT.-COL. M. G. BEKKER

Johns Hopkins University

GIVEN the same unit loads, a track-type vehicle may cross soft terrain without considerable slippage, whereas a wheel may slip excessively, or spin. This undesirable slip, varying in accordance with soil type, has bred controversy as to what extent a wheel, particularly a low pressure pneumatic tire, may replace a track or vice versa.

In this paper, the author concludes in general that although it is possible to provide wheels with the same ground contact as given by tracks, i.e., with the same "flotation," it is impossible to produce wheel traction without a considerable increase in slippage. However, this fundamental disadvantage of the wheel, or tire, may be overcome by adopting large

diameters, and thus large length, or by reducing the load.

The analytical method employed by the author to reach his conclusions is discussed at length in this paper. It is offered as a tool to help in the solution of the track versus wheel problem from the "flotation" and traction points of view as related to specific soil conditions. (Paper "Traction and Slippage of Caterpillars and Wheels" was presented at SAE Annual Meeting, Detroit, Jan. 12, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

More Light Thrown On Fuel Knock Problem

Based on paper by

JOEL WARREN

Ethyl Corp.

INVESTIGATIONS directed toward finding out why combustion-chamber deposits increase antiknock requirements have led to the formulation of certain conclusions. These may be stated as follows:

1. Substantially 100% of the increase in octane-number requirement caused by deposits results from a combination of thermal and volume effects.
2. Deposit-thermal effects have been found to be the result of a heat-capacity effect, wherein the incoming charge is heated by energy stored in the deposits from the previous cycle. They accounted for from 70 to 100% of the increase in octane-number requirement, depending upon the type of fuel used and the engine operating conditions.
3. Deposit-volume effects, obtained by determining the difference between the octane-number requirement at the deposit-equilibrium condition and after the compression ratio had been adjusted to the clean-engine value, accounted for from 0 to 30% of the increase in octane-number requirement, depending upon the same variables as in item 2.
4. Tests run with a leaded and a nonleaded commercial type fuel gave deposit-thermal and deposit-volume effects approximately in the middle range of values indicated in 2 and 3.
5. The relation between airflow and octane-number requirement was found to be the same when the head coolant temperature of the clean engine was elevated as when deposits from various fuels were accumulated in the engine, provided that deposit-volume effects were subtracted.
6. While generally believed that de-

posits with good thermal insulating properties should be expected to have large heat-capacity effects, in at least one instance certain deposits which had a very small insulating effect produced a large heat-capacity effect. The location of the deposits in the combustion chamber, the type of deposit structure, and their composition, may have been influencing factors in this case.

7. In summation, those engines with the smallest area of exposed combustion-chamber surface, for a given displacement, would be expected to have the smallest thermal effects, and hence, should have minimum deposit effects. (Paper "Combustion-Chamber Deposits and Octane-Number Requirement" was presented at SAE Annual Meeting, Detroit, Jan. 14, 1954. It is available in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion

Otto Enoch

Ford Motor Co.

The volumetric effects of deposits given by the author generally check with our test data. We find them varying greatly with operating conditions. The octane requirement increase due to thermal effects seems exceedingly high in Mr. Warren's Waukesha single-cylinder engine as compared with our multicylinder engine data. It could be argued that a smaller or major part of the difference is due to the much higher octane level. We know that the octane scale is inadequate to compare accurately differences in knock tendency in terms of octane numbers at different octane levels.

E. C. Hughes

Standard Oil Co. (Ohio)

Mr. Warren postulates that deposits hold and transfer heat to the fresh charge and that this is the major cause of deposit harm. While part of the effect of deposits may be a simple provision of heat to the gases, it would seem highly possible that another part would be due to a catalytic effect of the deposits on the heat-releasing pre-combustion reactions. The inclusion of catalytic effects has the advantage that it helps to provide an explanation for some remaining puzzling effects. For example, the powerful effect of smaller weights of nonleaded deposits is not well explained by the work thus far.

In tube oxidation work and occasionally in engine work, definite catalytic effects have been observed. Recent studies we have made on boron compounds and other "catalytic gasoline additives" have been successful in lowering octane requirement but a small part of the time. Strangely, they seem much more consistent in

reducing the amount of deposit. Nevertheless, these observations do not rule out the possibility that some of Mr. Warren's octane requirement is contributed through catalytic action as well as heat content of the deposits.

New Transmissions Reduce Vehicle Abuse

Based on paper by

W. D. PIDD

Chevrolet Motor Division, General Motors Corp.

WHEN cruising in drive range, the only working parts within the torque converter transmission are the two oil pumps and the governor, therefore wear is negligible. Operation in low or reverse gears, bringing into operation the reduction in the planetary gear set, is so infrequent that wear on these parts is negligible as well.

Transfer of road shocks through the drive line to the engine is minimized by the fluid coupling of the converter. It is also virtually impossible to overload the engine because the torque converter provides the proper ratio between engine output and power required.

This type of transmission is very economical to maintain. When cruising in drive range practically all units within the transmission rotate as a mass. The functions usually performed in the conventional transmission providing torque reduction are performed by fluid transfer within the hydraulic torque converter. (Paper "Chevrolet Powerglide Transmission" was presented at SAE Gulf Coast Section, Houston, May 14, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Type Oil Cuts Deposits and Knock

Based on paper by

R. L. Overcash
W. Hart
and
D. J. McClure

Kendall Refining Co.

LABORATORY tests of the effect of crankcase oils on the formation of combustion-chamber deposits have led

to seven conclusions concerning certain variables. These are:

1. The combustion-chamber deposit level normally reached with paraffinic oils containing residual stocks was unaffected by residual stock treatments such as dewaxing, propane deresining, and phenol extraction.

2. A naphthenic oil and low boiling paraffinic oils were improvements over blended paraffinic oil containing residual stocks. As the boiling range of distillate neutral stocks was increased, the oils contributed more to the formation of deposits, causing increased octane requirement.

3. The aromatic content of neutral stocks was varied as in solvent refining, but these variations did not affect deposit formation or knock resulting therefrom.

4. There was no evidence that inclusion of any of three viscosity index improvers was either detrimental or beneficial to the neutral stocks in their effect on octane requirement increase. Therefore it is possible to use a viscosity index improver to lessen oil consumption due to the low viscosity of the neutral.

5. Benefits found when using a base oil of neutral plus viscosity index improver can be further increased through compounding with the proper additives.

6. Crankcase oils were able to prevent large increases in octane requirements of a clean engine, but unable to lower the high equilibrium requirement of an engine previously lubricated with an oil containing residual stocks.

7. Crankcase oil which contributed little to combustion-chamber deposit formation in laboratory knock test, was also an improvement over oil containing residual stocks in laboratory preignition tests.

The following results were obtained in road knock and preignition tests:

1. An oil giving improved performance as measured by laboratory knock and preignition tests also improved road knock and preignition results over those obtained with oils containing residual stocks.

2. A semi-controlled field test with this new type of oil showed that knock and/or preignition complaints were eliminated or considerably delayed. (Paper "Crankcase Oil—An Approach to the Combustion Chamber Deposit Problem" was presented at SAE Annual Meeting, Detroit, Jan. 14, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion

C. A. Hall
Ethyl Corp.

Data showing the effect of oil volatility confirm our own and other published findings that removal of heavy ends from lubricating oils tends to

lessen the knocking tendencies of combustion-chamber deposits. We have found the magnitude of this beneficial effect, on requirement increase for ordinary knock, to be dependent on the contribution of the fuel to the organic portion of the deposits. In other words, the more volatile oils are most effective when used with clean burning, low end point, straight run gasolines in contrast with the more conventional present-day fuels.

R. K. Williams and C. R. Begeman
General Motors Research Laboratories

Reducing the harmful effects of combustion-chamber deposits through lubricant base stock selection and compounding will permit further increases in engine compression ratios which can be used satisfactorily by the public. However, there may be exceptions to the generalizations made with respect to the effects of volatility and base stock composition. There is still conflicting evidence. When we are able to make all of our theories consistent with all of the experimental evidence being accumulated, we will then be able to say whether volatility is the principal lubricant factor by means of which the harmful effects of combustion-chamber deposits can be controlled.

How to Cure Hydraulic Tappet Ills

Based on paper by

CARL VOORHIES

Chicago Screw Co.

A SUPPLY of relatively air free oil must be delivered to hydraulic valve tappets and care should be exercised to prevent a concentration of dirt in the oil fed to them. The hydraulic tappet will operate with normal dirt in the oil; but where lines are dead-ended at the tappet and dirt accumulates, trouble may be expected.

In one case under test conditions, a car had noisy tappets 5 to 10 miles after being driven fast over a crooked road. This did not happen when driven at the same speed over a straight road. With an observer to read the oil gage at high speed in a turn, it was discovered that oil pressure dropped to zero, confirming our suspicion that oil was leaving the pump inlet, due to centrifugal force, and that air was filling the lubricating system. Proper baffling in the oil pan provided the cure.

In another case, engine tests indicated proper tappet operation, but in proving ground tests the tappets became noisy immediately after long sustained maximum speed. Here it was found that the oil was being

aerated by being thrown from the crankshaft against the perforated baffle of the oil pan, dropping the oil pressure to zero. A solid pan baffle eliminated the trouble.

A blow-hole in an oil pump casting, which admitted air into the oil pump inlet, was found to be the cause of excessive noise in another instance. Replacing the casting cured the trouble. This example serves to show that any source of sufficient air can prevent proper tappet operation. And when a pump is circulating enough air to cause such misbehavior, it isn't doing the engine any good.

There is also a case where hydraulic tappets performed satisfactorily in thoroughly cleaned experimental engines, but became filled with cast-iron dust and made inoperative on production engines. We learned from this that dead-ending the oil feed line to tappets can cause an accumulation of dirt, resulting in a high percentage of failure in production.

The cure here was to change the oil feed to prevent dead-ending so that an oil relief valve provided an outlet at the end of the line. Under this set-up, large quantities of cast-iron dust could be mixed with the oil without causing failure.

Oil filters may be of some help, but they do not substitute for proper oil feed arrangement and are not essential for satisfactory hydraulic tappet operation. (Paper "Hydraulic Tappets, Why They Work, and What to Do If They Don't" was presented at SAE National Passenger Car, Body, and Materials Meeting, Detroit, March 5, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Brake Size and Design Influence Maintenance

Based on paper by

R. K. SUPER

Timken-Detroit Axle Division
Rockwell Spring and Axle Co.

YOU cannot expect to maintain a vehicle braking system at its full original efficiency and performance, hence it is important to recognize the permissible extent of deterioration. Minimum acceptable performance must base on what constitutes a safe brake. Law enforcement agencies have defined this requirement, but the desirable objective is actually that minimum braking ability which will meet traffic requirements and provide a margin for emergencies.

Traffic surveys show that a deceleration rate of around 8 ft/sec/sec covers the average braking rate for congested traffic or open highway driving. They also show that emergency requirements for brakes seldom exceed 12 to 13 ft/sec/sec. Using this fact in conjunction with surveys on actual brake stopping ability of commercial vehicles, indicates that a deceleration rate equivalent to a stopping distance of 30 ft from 20 mph was good performance. A maximum emergency braking ability based on a traffic requirement of 12 to 13 ft/sec/sec and an actual measured ability of 14.3 ft/sec/sec, would indicate the latter figure to be the minimum maintenance requirement.

Brake deterioration, therefore, is between the design or original performance of 19.3 ft/sec/sec (based on the recognized 0.6 adhesion factor be-

tween tire and road) and 14.3 ft/sec/sec, or an efficiency loss of approximately 25%.

This is a relatively narrow range within which to maintain equipment and the first impulse is to increase performance at the upper limit. The effect is desirable, particularly if overloading is recognized, but control and safety of the unloaded vehicle becomes a problem. No brake control problem is more illustrative of the bad effects of overloading than a tractor operating without trailer and having only the fifth wheel as the rear axle load. The most careful application of brakes will invariably result in wheel lock.

The ability to service brake equipment economically so as to operate consistently in the aforementioned range becomes a question of selection and application of brake sizes and designs. These sizes and designs are a function of the operational requirements and their relationship to maintenance is quite often overlooked or insufficiently emphasized. This may be due to association of brake sizes with brake performance. However, just as soon as repeated and continued performance is involved, the element of maintenance enters the picture. (Paper "Basic Maintenance Requirements for Brakes for Commercial Vehicles" was presented at SAE Annual Meeting, Detroit, Jan. 11, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

City Bus Brake Usage Greater Than Realized

Based on paper by

STEPHEN JOHNSON, JR.

Bendix-Westinghouse Automotive Air Brake Co.

PRESSURE balancing, that is, the uniformity of pressures at which the brake shoes of all wheels come in contact with the brake drums, is measured at relatively low pressures, approximately 5 psi. Its importance in bus operation is emphasized because the majority of braking pressures actually used are also relatively low.

To determine actual braking pressures, tests were conducted with 38 buses, comprising five makes and 16 models. The overall average stopping pressure was found to be 22 psi, and the overall average braking pressure, including stops and slow downs, was 18 psi. It is significant that 99% of the application pressures were at 45 psi or under, and 71.9% occurred at pressures ranging from 10 to 30 psi.

The data also emphasized the fact that brakes and the braking system are subjected to usage of a magnitude greater than many realize. Almost half the time a bus is in operation the brakes are being used. That is why brake maintenance is of such magnitude. (Paper "Pneumatic Aspects of Brake Balancing" was presented at SAE Annual Meeting, Detroit, Jan. 11, 1954. It is available in full in multilithographed form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Helicopter Engine-Propeller Attachments

Continued from Page 89

agreed that accessory power should be taken mechanically from the engine rather than via air turbines operating on air bled from the compressor. Experience has shown that for each horsepower generated by bleed air, 3 hp are lost from the turbine output shaft.

The question still puzzling the groups is: Where should the one or more power take-offs be located? Accessory power must be available not only during normal flight, but also during auto rotation and on the ground when the rotors are declutched from the engine. Somehow, the power must come from the rotor during auto rotation and from the engine during idling. This may require a duplication of take-offs or a duplication of power accessories.

- That the air inlet screen should retract is another point the groups agreed upon. Retracting the screen at altitudes where no inlet protection is needed improves inlet efficiency.
- The groups recommend also that the inlet screen be incorporated in the engine in such a way that the helicopter designer may provide a screen where it's most efficient and call for engines without the screen. Group members feel that the helicopter designer should be free to locate the screen in the most propitious place, which isn't always a spot controlled by the engine designer.
- Propeller shafts of piston engines can be shortened by half for helicopter use, the groups have agreed. This will save weight and space. Shortening is feasible because helicopter engine shafts aren't subject to the gyroscopic loads imposed by the airplane propellers for which the shafts were originally designed.

Present at the groups' January 6 meeting were Miller Wachs of Sikorsky, who served as chairman; H. C. Campbell of Eastern Rotorcraft; J. O. Emmerson of Kaman; A. Franz of Lycoming-Spencer; L. R. Hemlin of General Electric; D. S. King of Lycoming-Spencer; R. D. Lanning of Piasecki; G. W. Lawson of General Electric; B. Liff of Kaman; H. J. Nozick of Sikorsky; Earl Rich of Wright Aeronautical; Lt.-Com. J. M. Richards of the Navy Bureau of Aeronautics; R. F. Schwarzwalder of Wright Aeronautical; and Martin Stevens of Kaman.

The group concerned with gas turbine powerplants may form a panel under SAE Committee S-2 like the Panel on Project 50. S-2 is a committee of the SAE Aeronautics Committee's Special Aircraft Projects Division. Committee E-21 is a committee of the Aeronautics Committee's Aircraft Engine Division.

Aero Materials Specs Reviewed by Industry

DRAFTS of thirty-one SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division. Seven specifications have been approved recently by the SAE Technical Board.

Copies of all of these specifications are available for review from the SAE Aeronautical Department, 29 West 39 Street, New York 18, N. Y.

The specifications under review are:

- AMS 2241C—Tolerances, Corrosion and Heat Resistant Steel Bars and

Aero Materials Specs

continued

Titanium Alloy Bars;

- AMS 2645C—Fluorescent Penetrant Inspection;
- AMS 2646—Contrast Dye Penetrant Inspection;
- AMS 3207D — Synthetic Rubber, Weather Resistant, Chloroprene Type (25-35);
- AMS 3208D — Synthetic Rubber, Weather Resistant, Chloroprene Type (45-55);
- AMS 3240B — Synthetic Rubber, Weather Resistant, Chloroprene Type (35-45);
- AMS 3241B — Synthetic Rubber, Weather Resistant, Chloroprene Type (55-65);
- AMS 3250B—Synthetic Rubber and Cork Composition, General Purpose (35-45);
- AMS 3251B—Synthetic Rubber and Cork Composition, General Purpose (45-55);
- AMS 3252B—Synthetic Rubber and Cork Composition, General Purpose (55-65);
- AMS 3626B—Plastic Moldings and Extrusions, Methyl Methacrylate;
- AMS 4137A—Aluminum Alloy Forgings, 7.5Zn-1.6Mg-0.7Cu 0.55Mn (76S-T6);
- AMS 4574B—Nickel-Copper Alloy Tubing, Seamless, Corrosion Resistant 67Ni-30Cu, Annealed;
- AMS 4575B—Nickel-Copper Alloy Tubing, Brazed, Corrosion Resistant, 67Ni-30Cu, Annealed;
- AMS 4674B—Nickel-Copper Alloy Corrosion Resistant, 67Ni-30Cu Free Machining;
- AMS 4730B—Nickel-Copper Alloy Wire, Corrosion Resistant, 67Ni-30Cu Annealed;
- AMS 4901A—Titanium Sheet and Strip, Annealed-70,000 psi Yield;
- AMS 5350C—Steel Castings, Precision Investment, Corrosion Resistant 12.5Cr (SAE 51410);
- AMS 5370—Steel Castings, Precision Investment, Corrosion and Heat Resistant 19Cr-10Ni (Extra Low Carbon);
- AMS 5371—Steel Castings, Sand,

Aero Materials Specs

continued

Corrosion and Heat Resistant 19Cr-10Ni (Extra Low Carbon);

• AMS 5375B—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base-25Cr-1.8Ni-5W;

• AMS 5376B—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Iron Base-21Cr-20Ni-20Co-3Mo-2.5W-1(Cb + Ta);

• AMS 5378B—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base-25Cr-32Ni-5.5Mo;

• AMS 5380B—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base-26Cr-15Ni-6Mo;

• AMS 5385C—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base-27Cr-2.8Ni-5.5Mo;

• AMS 5388A—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Nickel Base-16Cr-17Mo-4.5W-6Fe;

• AMS 5516D—Steel Sheet and Strip, Corrosion Resistant, 18Cr-8Ni (SAE 30302), Cold Rolled-75,000 psi;

• AMS 5527A—Steel Sheet and Strip, Corrosion and Heat Resistant, 20Cr-9Ni 1.4Mo-1.4W-0.4(Cb + Ta)-0.2Ti, Hot Rolled and Stress Relieved;

• AMS 5539A—Steel Sheet and Strip, Corrosion and Heat Resistant, 20Cr-9Ni 1.6Mo-1.4W-0.6Ti, Hot Rolled and Stress Relieved;

• AMS 5566C—Steel Tubing, Corrosion Resistant, 19Cr-10Ni (SAE 30304) High Pressure Hydraulic;

• AMS 5643C—Steel, Corrosion Resistant, 17Cr-4Ni-4Cu;

• AMS 7470A—Bolts and Screws, Steel, Corrosion Resistant, Heat Treated—Roll Threaded.

The approved specifications are:

• AMS 3315B—Silicone Rubber Sheet, Glass Fabric;

• AMS 5525—Steel Sheet and Strip, Corrosion Resistant;

• AMS 5628B—Steel, Corrosion Resistant;

• AMS 5647—Steel, Corrosion Resistant;

• AMS 5724—Steel, Corrosion and Heat Resistant;

• AMS 5729—Steel, Corrosion and Heat Resistant;

• AMS 5733A—Steel, Corrosion and Heat Resistant.

New Members Qualified

These applicants qualified for admission to the Society between Feb. 10, 1954 and March 10, 1954. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

British Columbia Section

Donald James MacKenzie (A).

Buffalo Section

Manford Earl Folsom (M), William James Hazen, Jr. (J), Douglas D. Joyce, Jr. (J), Edward Urycki (J).

Canadian Section

T. S. Adams (M), James W. Fry (M), George Andrew Sparrow (A).

Central Illinois Section

John M. Bailey (J), Cecil D. Beadles (J), Robert Lee Behrens (J), Robert E. DuBois (A), Gustav G. Lindstrom (M), Edward L. Morris (M), Richard L. Robinson (A), Lyle F. Yates (J).

Chicago Section

Frank J. Acton (M), John M. Krizman (M), Walter J. Oliver (J), E. Verne Sprunger (J), Edward F. Tausk (J), Herbert A. Wilson (J).

Cincinnati Section

Arthur R. Ehrnschwender (M), Thomas Evans (M), Reginald P. MacDonald (M), James S. Wilson (M).

Cleveland Section

Theron J. Baker (M), Robert E. Dyas (M), Raymond Herman (A), William Cairns Leslie (M), Paul C. Rector (M), Hugh Thurnauer (M), Warren J. Young (J).

Dayton Section

Hugh J. Byrd (J), 2nd Lt. Joseph Francis Cattorini (J), T. R. Dick (A), Claude Hector May (M), Howard I. Spelman (A).

Detroit Section

Meredith P. Albertson, Jr. (M), Harvey J. Ankomeus (A), Harold J. Barber (J), Robert P. Benzinger (J), Sherman Louis Bremer (J), Edwin K. Buyze (M), Phillip E. Chase (J), Warren W. Coleman (M), Don Dence (M), William L. Doerr (J), C. A. Ebersole (A), Glenn S. Farison (M), H. Wayne French (M), Howard E. Geldhof (J), Dr. Ing. Herbert H. Haas (M), Dwight M. Hayne (M), Robert W. Hebel (J), Robert L. Hoenk (A), Joseph J. Ihnacik, Jr. (M), Michael H. Kleinman (J), Arthur F. Kessie, Jr. (M), Norman C. Krupp (J), E. C. Lea (M), Norman H. Ledwan (M), John A. Main (M), Walter Robert McLure (J), William Melnyk (M), Robert D. Mitchell (J), John A. Mowbray (M), Larus J. O'Brien (J), Tollef Lintrup Paus (M), Harvey Raymond Pickford (J), Samuel S. Platner (M), George Popovich, Jr. (J), Edmond J. Ray (A), Stanley H. Reich (J), Raymond J. Ribant (M), William F. Saefkow (A), Herbert P. Schell (M), Earl W. Sheedy (M), H. Conrad Sonderegger (M), John Worley Stafford (M), John E. Stepleton (A), John Townsend Thode (J), Harry Thomas (M), Henry Tischler (A), Patrick Wallace (A), Gordon Ellis Whelpley (M), Charles M. G. Wilder (J), Raymond J. Wrobel (J), Floyd A. Wyczalek (M).

Indiana Section

Mason Noble (M), Robert G. Walker (J).

Kansas City Section

Henry E. Hutchings (A), Robert Ewing Jones (J), Robert Ellerman Langley (J).

New Members Qualified

continued

Metropolitan Section

G. Beakes Dickerson (M), Edward Junior Hollman (J), Eugene H. Koenig (M), Joseph C. Ryan (J), George W. Taylor, Jr. (J), Charles W. Wilson (M), Allen P. Wolfe (A).

Mid-Michigan Section

Gordon B. Elder (M), Bruce Melvin Kemppainen (J), Walter F. Long (M), Ralph A. Malone (M), Arnold T. Schmidt (J), John G. Zelenka (J).

Milwaukee Section

Philip W. Fauntleroy, III (J), Arthur C. Flamme (M), Stanley F. Lindquist (J), David C. McMurray, Jr. (J).

Montreal Section

W. D. Dawson (A), Alphonse Grise (M).

New England Section

Arthur J. Clark (A).

Northern California Section

Rick V. Espinosa (A), Joseph William Menconi (A).

Northwest Section

Darell A. Buell (A), William D. Cordz (A), Donald H. Dehn (J), Robert B. Dickey (M), Sanford E. Webb (J).

Philadelphia Section

Joseph P. Heidt (A), R. F. Shugert (J).

St. Louis Section

John W. Kourik (M).

San Diego Section

Don Durnal (J), Jean R. Kohl (M), George A. Lemke (M), Herbert P. Rasp (M), Robert Lloyd Trussell (M).

Southern California Section

Ed S. Burdick (A), Thomas R. Clark (A), Douglas Frank Corsette (J), Robert E. Field (J), Walter E. Hekala (M), Kenneth Jeanne Kahre (J), Perry L. Kruckenberg (M), Joseph Lotrick (J), Michael Moroso (J), James G. Myer (A), Charles B. Pearson (M), James F. Renhult (J), Robert James Ross (M).

Southern New England Section

Carl A. Bailey (M), David W. Cogswell (J).

Continued on Page 118

New Members Qualified

continued

Syracuse Section

Peter V. Schneider (M), David C. Wright (J).

Texas Section

Ronald Eugene Freise (A), Thomas D. Hughston, Jr. (J).

Texas Gulf Coast Section

George C. Schaefer (A).

Western Michigan Section

Leslie A. Cole, Jr. (J).

Outside Section Territory

Lee G. Cochran (M), William E. Deluhery (J), Orvis J. Fairbanks (A), Charles S. L. Frances (M), John Frederick Frank (J), Oliver L. Grimes (J), Kingsley E. Humbert, Jr. (M), Richard Walter Lace (M), Joffre Poincare Myers (A), Carlo J. Roma (J), Peter Jacobus Visser (M).

Foreign

Sat Brat Gupta (M), India; Tokushiro Ohzato (M), Japan; Flight Lt. Tarasingh (M), India.

Applications Received

The applications for membership received between Feb. 10, 1954 and March 10, 1954 are listed below.

Alberta Group

Gordon Forster, Percy Earl Walsh.

Baltimore Section

James Calvin Anton, Richard Frederick Depkin, John N. Lyndall, Jr., Robert Clayton Mellin.

British Columbia Section

Douglas A. Court, Walter Harrington.

Buffalo Section

Matthew L. Spitzer, Robert A. Witte.

Canadian Section

Eric M. P. Caunce, J. D. Elliott, Norman Andrew Kennedy, J. Stanley Roberts, Frank E. Wherley.

Chicago Section

Harry H. Baker, Donald L. Cauble, Russell F. Denney, Ferdinand Fuentes, John Warner Layman, John E. Mahoney, David L. Stevenson, John Thayer, Milton K. Wells.

Continued on Page 120

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Applications Received

continued

Cincinnati Section

Robert T. McSorley, Herman W. Richter, John A. Schreibeis, William H. Sontag, Kenneth W. Stalker.

Cleveland Section

Ernest J. Balchak, Joseph T. Clark, Bruce W. Cox, William C. Eaves, Albert G. Hepp, William George Herridge, Jr., Robert A. Leitch, William Luthi, Raymond P. Michnay, Elmer P. Orvis, George E. Payne, Joseph V. Poticny, Donald E. Schott, Andrew Richard Schurger, Charles F. Smith, Carl J. Stahl, William Thomas Wintucky.

Colorado Group

Hugh Caughey, Clay W. Dintaman, Forrest E. McGrath.

Dayton Section

J. A. Lawler.

Detroit Section

Paul C. Bailey, Ritchie S. Barrie, Jr., Richard J. Bernock, Joseph B. Bidwell, Samuel G. Brady, Charles P. Burr, Frank M. Caram, Theodore E. Coffman, Robert Cowell, Arthur J. Davidson, Jr., Eugene B. Delaney, Allen R. Elliott, Joseph W. Fargo, Donald John Fergle, Edward P. Francis, Irving Frazee, Donald Nelson Frey, Victor H. Geyer, Walter Gibbs, Jr., Allen F. Gifford, John W. Gillespie, Burck E. Grosse, Oliver R. Halonen, Allan A. Harris, George E. Hooton, Norman A. Hunstad, Louis Liggett Hunt, James A. Joyner, Joseph P. LaGore, Zelig Landy, Robert John Lothamer, Felix P. Noring, Reno Offringa, Jr., William Carl Ohmee, Jr., Gleaves Logue Omohundro, Robert W. Rauth, Charles Noel Richardson, Frank F. Rycamber, Earl J. Scanlon, R. M. Smiley, Helge B. Sorensen, Thomas Clayton Spalding, Robert Frank Wood.

Hawaii

James F. Pell.

Indiana Section

Fred G. Bonfils, Roger A. Dull.

Kansas City Section

Ben F. Gregory, Charles J. Ritsch, Ray R. West.

Metropolitan Section

William Joseph Coppoc, Francis A. C. Eisele, Nat Infurna, Walter Henry Leemann, Martin Leff, Charles E. Moser, William A. Raftery, Firmin E. Rondepierre, Edwin A. Speakman, John W. Thompson, John S. Walker.

Mid-Michigan Section

James F. Beckwith, William E. Splinter, Paul C. Traub.

Applications Received

continued

Milwaukee Section

Clyde Kuhlman, Robert George McIndoo, David J. Munroe.

Montreal Section

A. D. Williscroft.

New England Section

Budd Lynn Kehne, Gerhard Reethof.

Northern California Section

Thomas Adolph Golden, Eugene Cooper Johnson, Jr.

Philadelphia Section

Maynard R. Hunter, Robert W. Kinkle, William David Preston, James Edward Ridgway, Floyd J. Sisto, John I. Wheeler.

Pittsburgh Section

Joseph A. Martinsek.

St. Louis Section

Murry C. Glick.

Salt Lake Group

Calvin Warner Dunbar.

San Diego Section

Herff C. Emerson, Howard G. Engler, John Richard Payne, Aulden C. Reading, John F. Schroepfer, Jack C. Thompson.

Southern California Section

Everett H. Badger, Herbert Gordon Blinn, Vaughn E. Connolly, Cleo R. Davidson, Thomas E. Davidson, Harry A. Faris, Richard D. Hitt, Roy N. Moore, Johannes S. Newton, Wilfred A. Pulver, Harold W. Sears, L. Elliot Weir.

Southern New England Section

J. D. Gillilan, Reinhold H. Hollinger, Stanley L. Macklis.

Texas Section

Robert Niell Jones.

Texas Gulf Coast Section

Bill Ball, M. W. Frack, R. A. J. Dawson.

Western Michigan Section

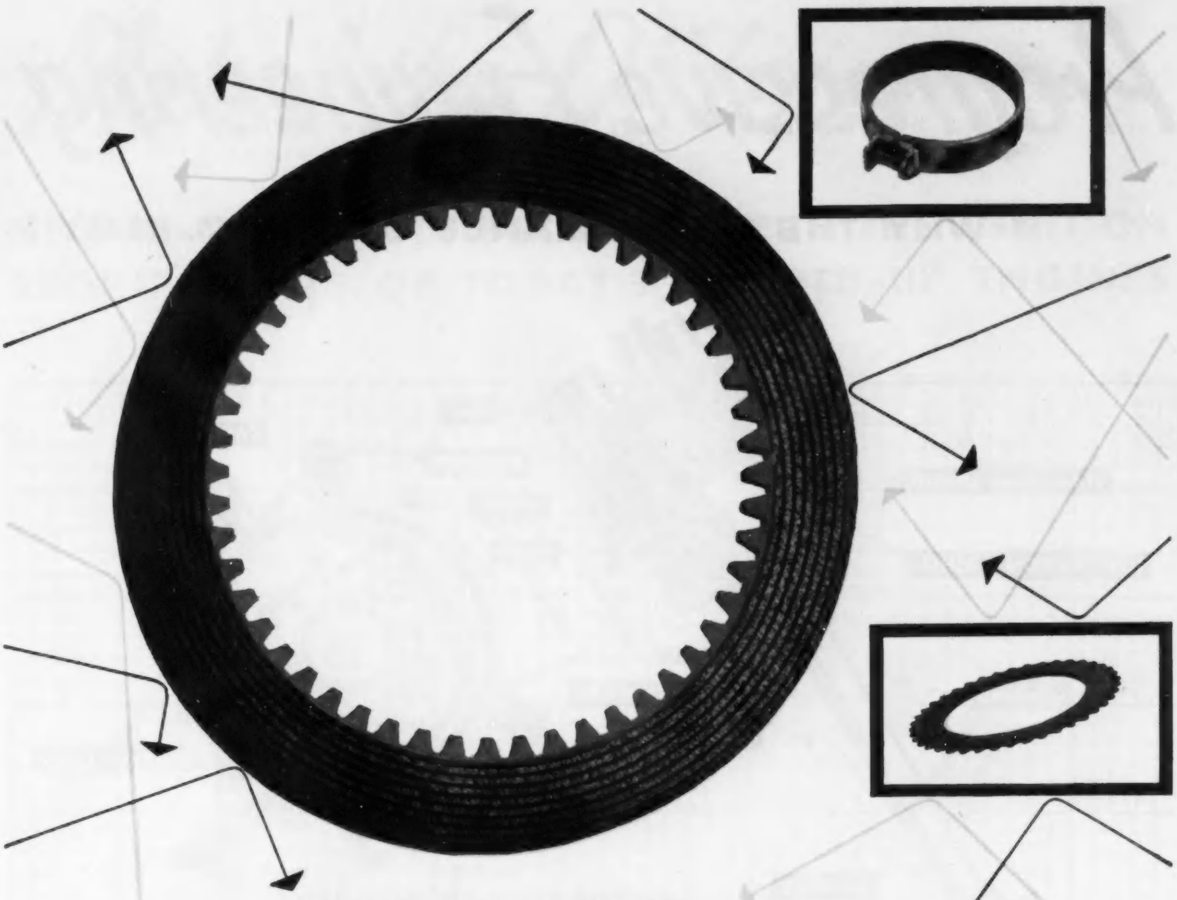
Leonard Edelstein, William McGarvey, E. R. Nelson, Ray O. Smith.

Outside of Section Territory

Louis M. Bachinski, Thomas Hubert Dacus, Carlton R. Davenport, F. L. Napple.

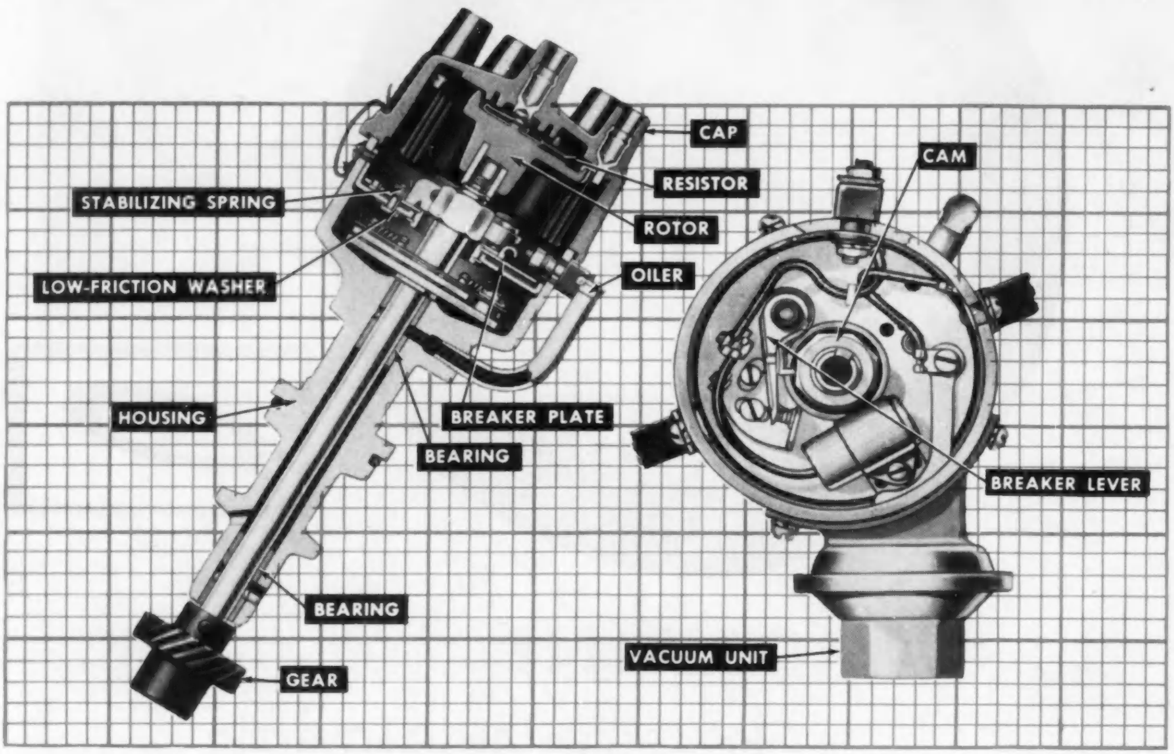
Foreign

Walter B. Hough, Jr., Lebanon; V. L. Shah, India; K. Venkat Swamy, India; George Collins Wade, Australia.



Progressive Engineering

WHY THE PERFORMANCE OF DELCO-REMY'S



How Progressive Engineering at Delco-Remy results in continually improved products, and improved methods of making them, is particularly evident in the units comprising the Delco-Remy 12-volt electrical system for passenger cars. Take for example, the 12-volt distributor.

This cutaway view of a typical 1954 model shows some of the many highly effective features which enable Delco-Remy distributors to exceed the ignition requirements of the latest high-compression, better-breathing passenger car engines. Note the taller, overhanging all-weather cap with wider insert spacing and sharply ribbed interior which handles today's higher ignition voltages with minimum losses under the most adverse weather conditions . . . the new larger matching rotor with its built-in resistor for radio suppression . . . the new high-rate-of-break cam and high-speed breaker lever . . . the new long-reach twin bearings for more precise shaft control . . . the positive lubrication . . . the accurate drive gear made of durable cast alloy.

But that's not all! Note the remarkable performance of this distributor as shown by the curves . . . the generous road load advance which easily meets every timing need for maximum fuel economy . . . the

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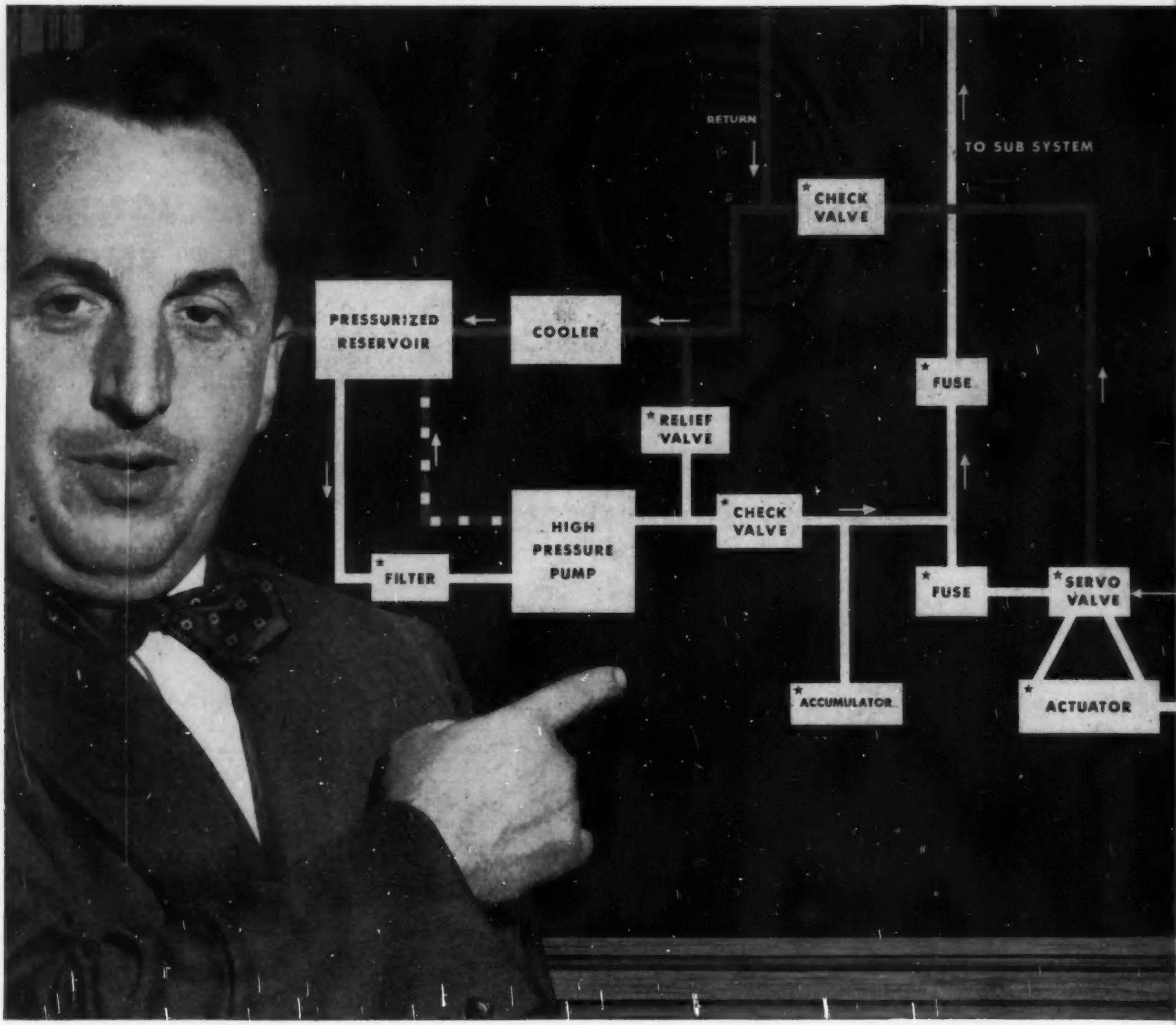
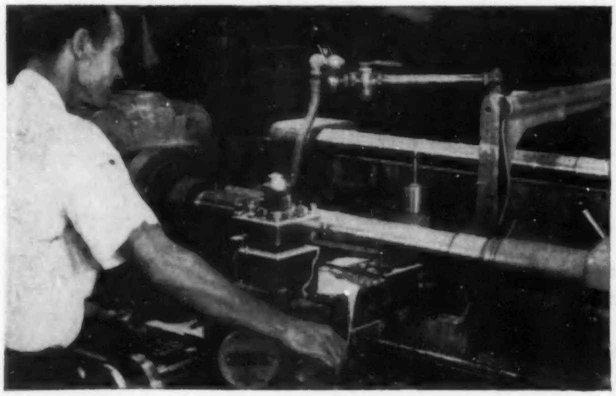
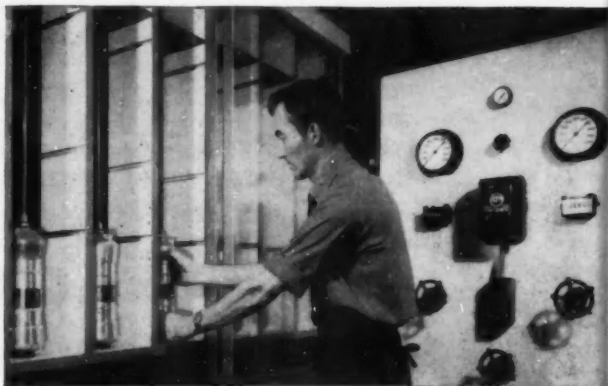


Typical hydraulic system with two subsystems in which all starred units indicate top-quality accessories offered by Parker's Engine Accessories Division. For example, our piston-type accumulators assure quick response and are thoroughly tested for safe operation. They operate at temperatures up to 250°F. Accumulator sizes range from 10 to 400 cubic inches.



Advanced manufacturing techniques save time. This duplicating lathe turns close-tolerance outside diameters of accumulators in fraction of time required by standard lathes.



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The locality doesn't seem to make any difference nor does the trucking operation. For whether it's up in the Pacific Northwest or down on the Florida Gulf, hauling timber or tobacco, more trucks are equipped with Bendix-Westinghouse than with any other air brakes! The reason for this overwhelming preference is simple—Bendix-Westinghouse Air Brakes deliver more miles of satisfactory performance at lower cost than any other air brakes on the market. Why not keep it in mind next time you specify braking equipment?
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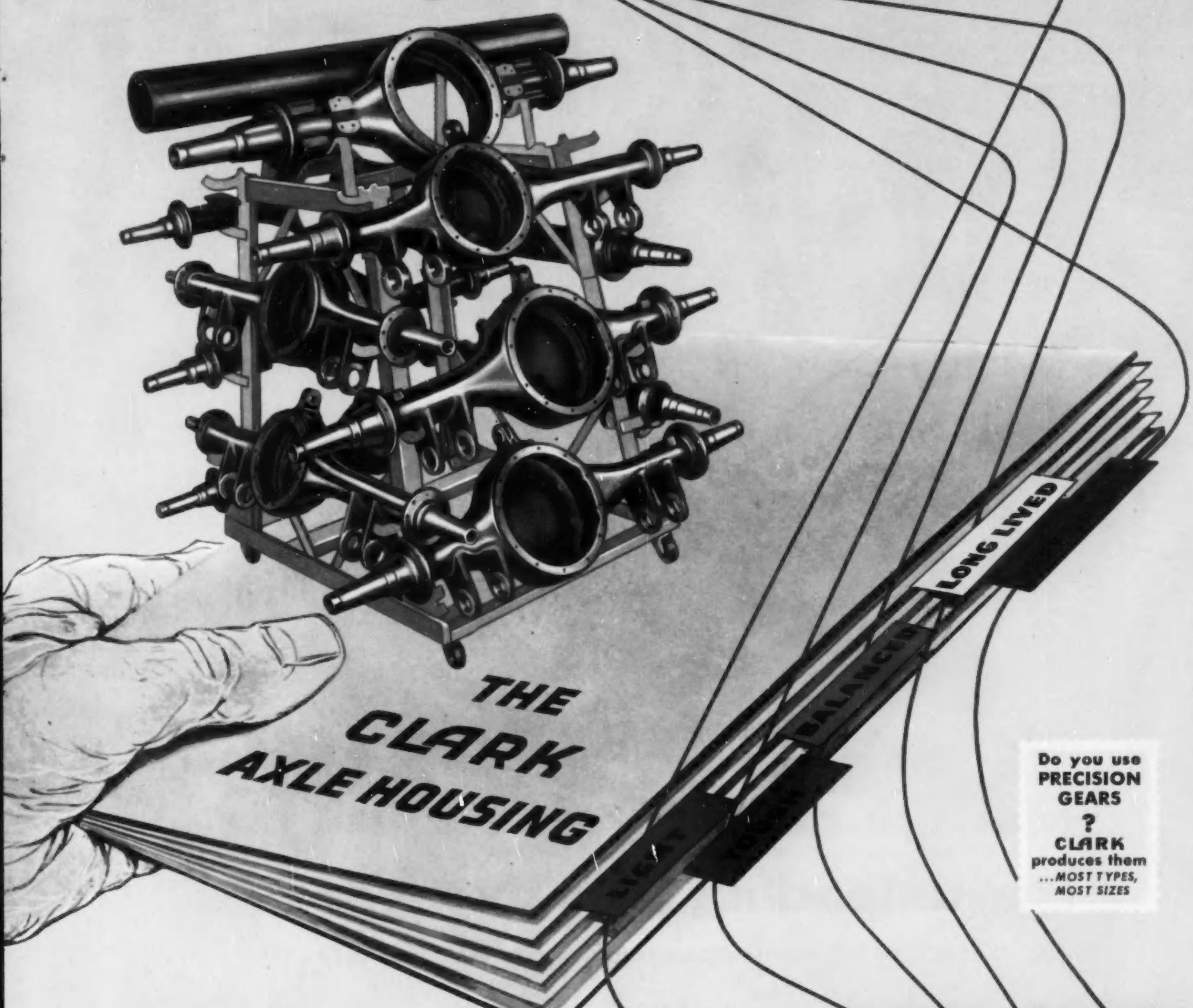
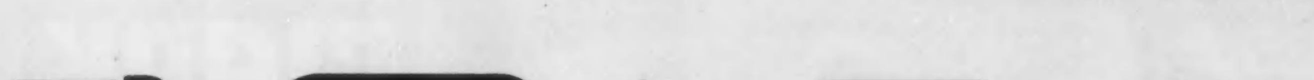
It's Unique



Do you use **PRECISION GEARS**?
CLARK produces them
...MOST TYPES, MOST SIZES

An ideal answer to your problem?—Could be: this unique one-piece forged heat-treated housing, produced in a variety of designs and sizes. You'll find it's "good business" to do business with Clark

CLARK EQUIPMENT



CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Benton Harbor and Jackson, Michigan

"Clark Fork Trucks increased storage capacity one-third, cut car-unloading time by more than 50%"

SAYS **JOSEPH PALESE**, PLANT SUPERINTENDENT, SALERNO-MEGOWEN BISCUIT CO., CHICAGO

In this Salerno bakery, one of the world's largest, you find four Clark electric fork trucks and three Clark Powrworker hand trucks—unloading and storing raw materials and handling palletized cartons ready for shipment.

Practically all material received from local suppliers—bags of flour and sugar, drums of oil and shortening, other items in boxes, sacks, rolls—is loaded on pallets manufactured by Salerno, and furnished by them to suppliers. The busy Clarks take over at the receiving doors, and handle materials throughout the full production cycle. Benefits are substantial: a 33% increase in storage capacity and car-unloading time cut by well over 50 per cent.

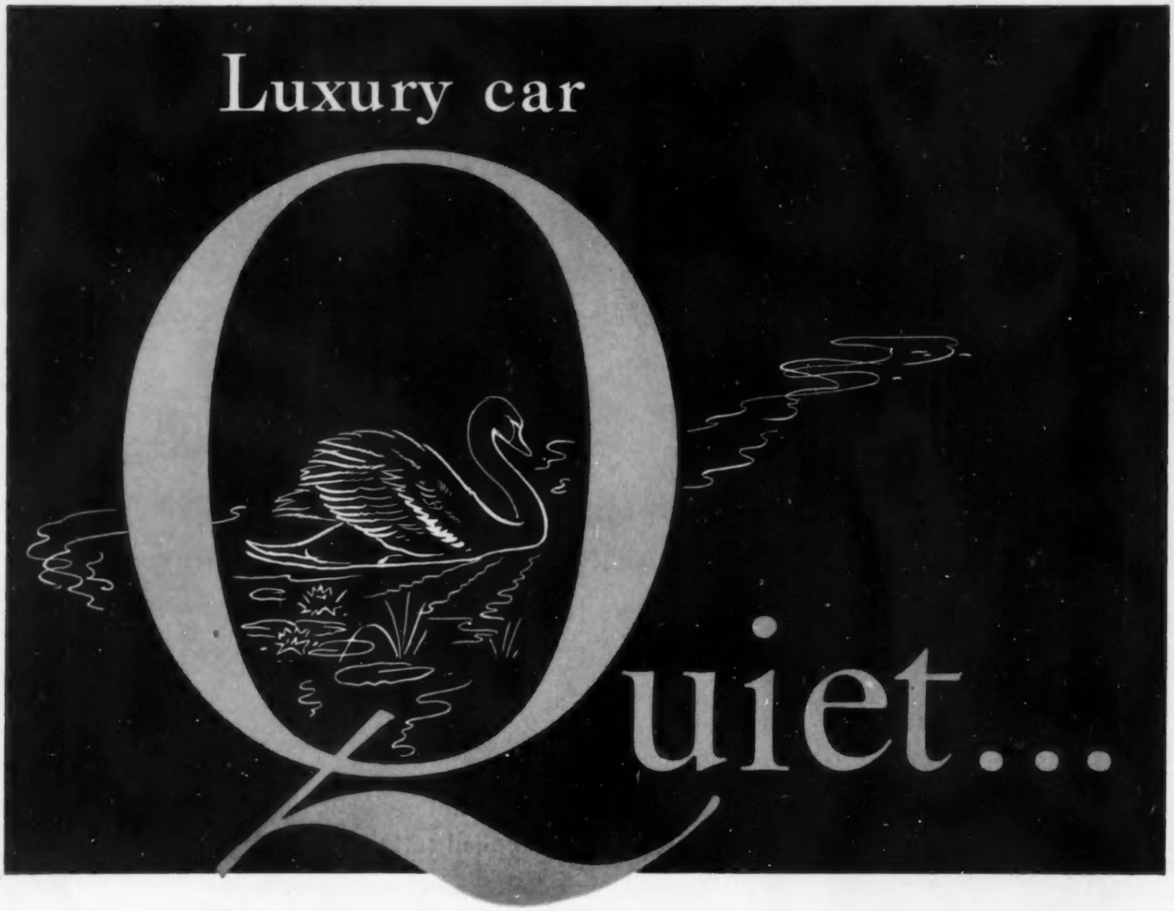
"We are completely satisfied with our Clark machines, and have three more on order," says Mr. Palese.

These benefits can be yours—simply call your local Clark dealer, listed in the Yellow Pages of your phone book: a good man to help engineer a handling system to meet your needs.

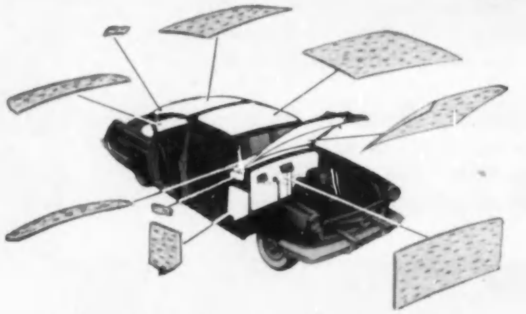
Industrial Truck Division
CLARK EQUIPMENT COMPANY
BATTLE CREEK, MICHIGAN

CLARK EQUIPMENT

PRODUCTS OF CLARK—TRANSMISSIONS • AXLE HOUSINGS • TRACTOR UNITS FORK TRUCKS and TOWING TRACTORS • ROSS CARRIERS • POWRWORKER HAND TRUCKS • POWER SHOVELS • ELECTRIC STEEL CASTINGS • GEARS and FORGINGS • FRONT and REAR AXLES for TRUCKS and BUSES



in cars of every price



L·O·F Super·Fine Fiber·Glass insulates a car throughout against heat, cold and sound. Installed under the hood, it reduces high-frequency engine sounds, transmitted tire whine, and air stream whistle.

When Libbey·Owens·Ford introduced safety glass, it was at first specified for windshields only. Before long, its use was common in all windows of all makes of cars, including the lowest priced . . . Today, with Fiber·Glass insulation used to some extent by cars in every price class, further and fuller applications are being studied by all automobile manufacturers.

When the adoption of Fiber·Glass insulation for automobiles becomes universal, all cars will bring to their owners the best of all-around insulation against heat, cold and airborne sound.

Our Detroit office will be glad to give you more information on quality automotive insulation—610 Fisher Building, TRinity 5-0080. Or write: Libbey·Owens·Ford Glass Company, Fiber·Glass Division, 644 Wayne Building, Toledo 3, Ohio.

LOF GLASS · LOF Corrulux · LOF FIBER·GLASS

FIBER·GLASS

LIBBEY·OWENS·FORD GLASS COMPANY • FIBER·GLASS DIVISION • TOLEDO 3, OHIO

Among leading automotive manufacturers

the swing's to timing chain...

and LINK-BELT Timing Chain gives you these 3 BIG advantages

Segmental bushings provide automatic joint snugness

Segmental bushings are made with slight bow.

After initial assembly in chain, bushings are straight.

Bow in bushing acts to keep a snug joint.

1. **Automatic joint snugness**
2. **Smoother operation**
3. **Longer life**

YES, more and more new automobile engines are being designed for timing chain. And when it comes to timing chain—no other make can match Link-Belt's outstanding advantages. What's more, the tremendous facilities of the Link-Belt plant—the world's largest chain plant—assure you a dependable source. Our engineers will supply a test drive to your specifications. For full information, ask for Book 2065.

13,344

LINK-BELT

TIMING CHAINS and SPROCKETS

LINK-BELT COMPANY: 220 South Belmont Ave., Indianapolis 6, Ind. Offices in principal cities.

"U. S." brings its research lab right into your office

Without moving from your chair, you can summon United States Rubber Company engineers from their office in the New Center Bldg., Detroit. These experts are your direct link with the "U. S." plant at Fort Wayne, housing the great research laboratory for the automotive industry.

At Fort Wayne, "U. S." makes engineered rubber and plastic parts, rubber-bonded-to-metal parts. In the laboratory, physicists, metallurgists, chemists and design engineers are constantly probing and testing, seeking new developments that will improve your product. Backed by stockpiles of research data, furnished with the most modern equipment, these "U. S." engineers will tackle any problem you care to give them. For full information, phone Trinity 4-3500 and ask for Mechanical Goods Division, or write to address below.

"U. S." Research perfects it
"U. S." Production builds it

US RUBBER

UNITED STATES RUBBER COMPANY

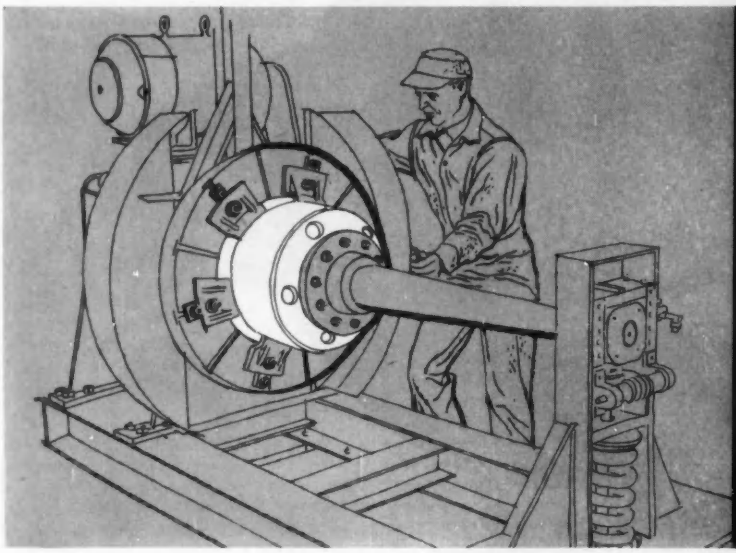
Automotive Sales, Mechanical Goods Division, New Center Bldg., Detroit 2, Michigan

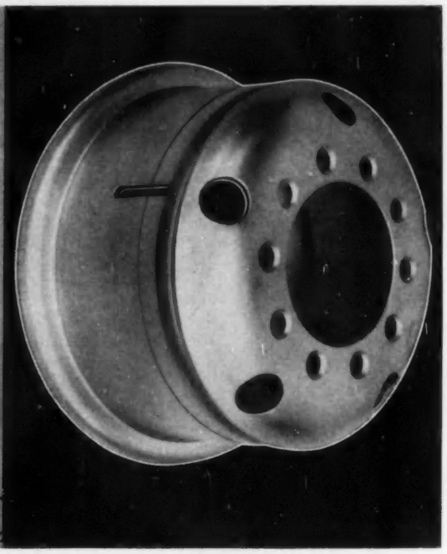
McQUAY-NORRIS

PISTON RINGS

Since 1910, McQuay-Norris has played a leading role in the piston ring field. This background of more than 43 years experience is available to manufacturers who require engineering and production skills of the highest standard.

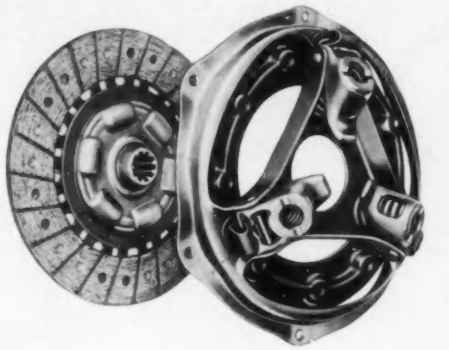
McQUAY-NORRIS MFG. CO. • ST. LOUIS 10, MO.





THIS IS THE AUBURN CLUTCH DIVISION AT AUBURN, INDIANA

Thousands of Spicer Brown-Lipe and Auburn Clutches are produced daily in the Auburn Clutch plant, for use in many popular automobiles, trucks, buses, tractors, and industrial applications.



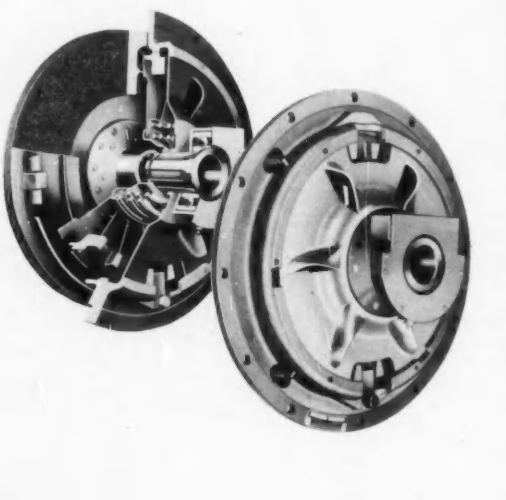
Millions of Auburn Clutches in Active Daily Service

Auburn Clutches have been approved and accepted as original equipment since 1937. They are manufactured in a new, modern plant, fully staffed and equipped with the most modern tools and systems for an annual capacity of over a million complete clutch assemblies.

Major features include:

25% Less Weight • 30% Fewer Parts
Runs Cooler • Longer Pressure Spring Life
Torsional Vibration Damper • Patented Flexible Center
Patented Cushion Eliminates Chatter
New Positive Pressure Plate Return • Wide Range of Sizes

The Brown-Lipe Clutch Offers Outstanding Performance for Heavy-Duty Trucks and Buses



Features include:

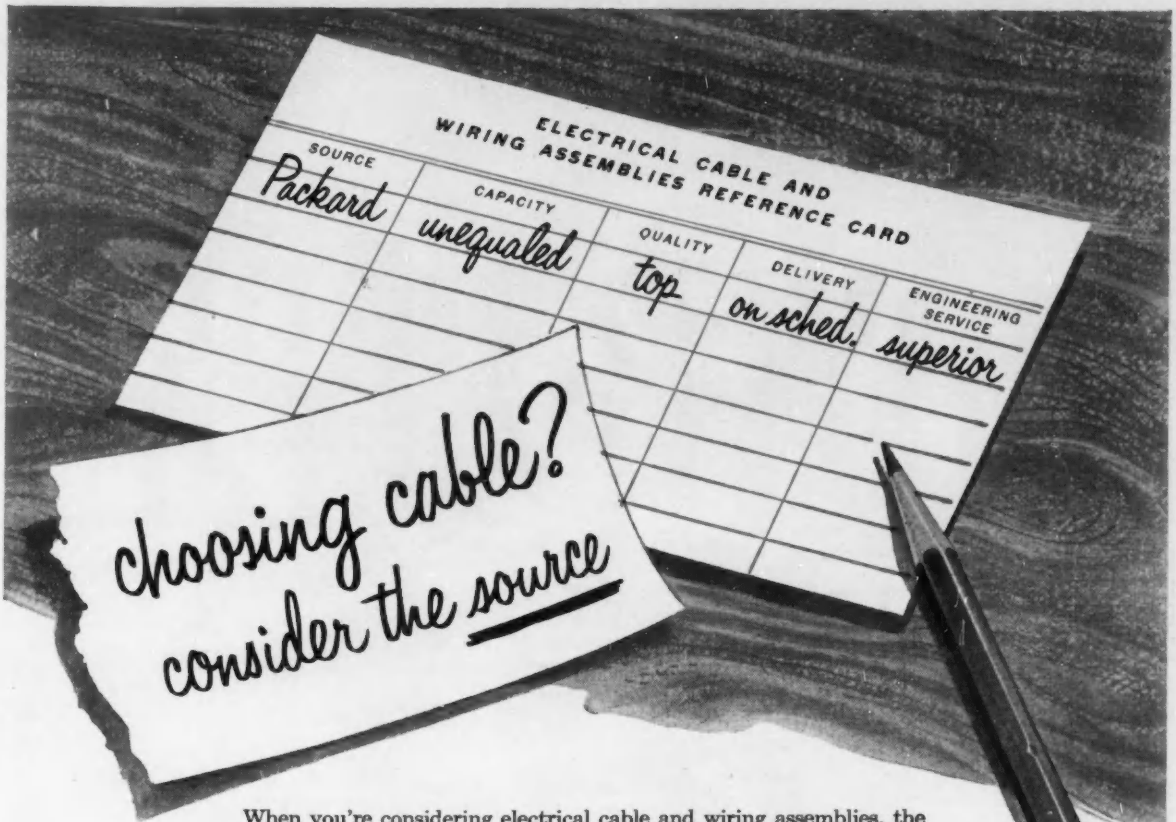
INSULATED SPRINGS. Not in contact with pressure plate; heat from plate cannot destroy their temper.
UNIFORM OVERALL PRESSURE. Through 360° of pressure plate.
SIMPLE SCREW THREAD ADJUSTMENT. Permits quick, easy adjustment.
SMOOTH. Flexibility of levers results in smooth pick-up.
NO CHATTER. Assures longer life.
LOW PEDAL PRESSURE. Remains essentially constant throughout clutch life.
FEWER PARTS. Greater efficiency with less upkeep.
ECONOMICAL. Low maintenance cost. Long-life performance.

SPICER MANUFACTURING DIVISION
of Dana Corporation • Toledo 1, Ohio

50 YEARS OF Spicer SERVICE

ENGINEERING DANA MANUFACTURING

TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • BROWN-LIPE AND AUBURN CLUTCHES • FORGINGS • AXLES • STAMPINGS • SPICER BROWN-LIPE GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • AIRCRAFT GEARS • WELDED TUBING



When you're considering electrical cable and wiring assemblies, the first requirement is uniform high quality. But, above and beyond quality, consider also certain intangibles—such *plus* advantages as experienced engineering counsel and assured delivery in any quantity you need. Often it is these intangibles that help you keep your production lines going.

Consider Packard as a source

Product *quality?* The wide choice of Packard, by America's foremost manufacturers of automotive vehicles, aircraft and appliances, is your answer.

Capacity and delivery? Packard is equipped to produce more than 7,000,000 feet of finished cable, and 800,000 wiring assemblies, *daily* . . . and to maintain delivery schedules unfailingly.

Engineering service? A large staff of Packard engineers is ready to serve you at any time, at any place. Call on them—the earlier, the better, preferably while your new product or model is still on the drafting board. Our engineering counsel has often effected important savings in assembly costs.

Packard

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AUTOMOTIVE, AVIATION AND APPLIANCE WIRING


AUTO-LITE


"DETROIT"
Universal Joints . . .
. . . Carry the Load for
Numerous Types of Vehicles

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NATIONAL AUTOMOTIVE FIBRES, INC.

Presents

MOORESVILLE

FROM FIBER TO FABRIC

the newest automobile fabrics from one of America's foremost resources

Smart styling . . . luxurious coloring . . . durable construction—Mooresville fabrics have the distinctive good looks and dependable performance of today's modern cars. No wonder, because

. . . from fiber to fabric, Mooresville takes a design creation through every quality controlled step—the selection and spinning of yarns, their blending, weaving and finishing into novel and intriguing decorative materials.

Beautiful fabrics and the vast facilities of a leading textile mill are not enough to inspire complete confidence. Mooresville Mills has a proven reputation for respecting and protecting confidential information and for delivering during crucial production periods. Therein lie the greatest strengths as a resource for you and for us.

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Subsidiary: Canadian Automotive Trim, Ltd.
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PLANTS:
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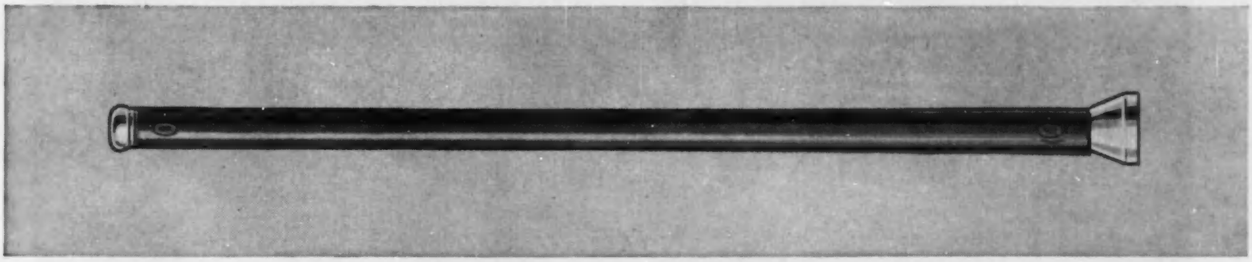

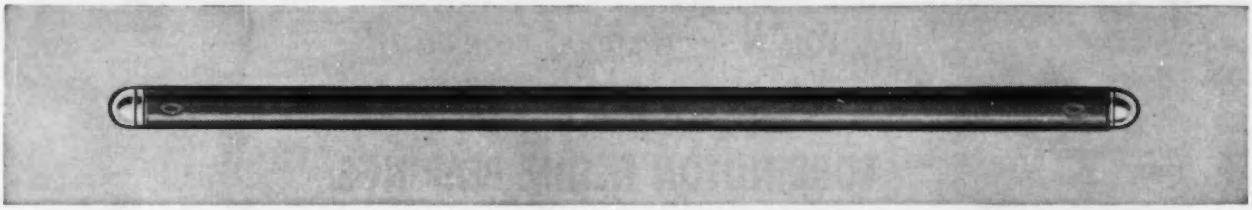

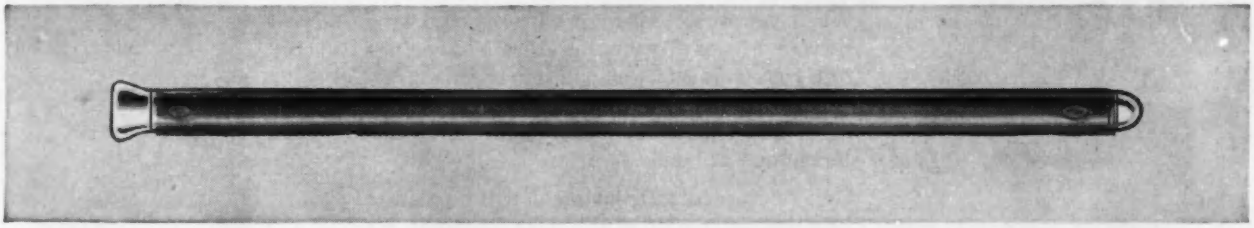

2 Tough, lightweight push rods of hardened Bundyweld reduce cam load; increase efficient function of entire valve train. Bundyweld fabricates more easily than the material it replaces; results in more uniform, better finished parts. End inserts are easily spot welded to tubing.

Long used in many passenger-car and truck engines, lightweight push rods of Bundyweld have helped design engineers produce more powerful overhead-type engines.

These tough push rods reduce load on cam, and, of course, the entire valve train follows the cam more closely. The design engineer is thus able to produce a more efficient, more powerful overhead engine, in keeping with today's constantly growing trend.

The tubing: Bundyweld is the only tubing double-walled from a single metal strip, with patented beveled edges. It's SAE 1010 steel, copper-bonded throughout 360° of wall contact into a strong, lightweight, beadless tubing. Wall thickness and concentricity are uniform, accurate. Ultimate tensile strength, yield strength, and fatigue limit are exceptionally high.

Engineering help: If you'd like help in determining how to apply Bundyweld toward solving your push rod problems, why not talk things over with one of our experienced automotive tubing engineers? You'll find them a prime source of sound information and ideas – not only on push rods but on all other automotive tubing applications.

Production: We're already turning out quantities of tubing for automotive push rods. And, naturally, we're ready to give you the same high-volume, low-cost service we're giving others. We'll ship Bundyweld – cold drawn to proper hardness, held to specified low camber tolerances–right on schedule.

Let us show you what we've done – and what we can do for you – with push rods of Bundyweld Tubing. Perhaps you'd like to check into Bundyweld for your gasoline, oil, hydraulic window or brake lines, too. For details, write Bundy Tubing Company, world's largest producer of small-diameter tubing.

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St. East.
Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

P&H
HARNISCHFEGER CORP.
STANLEY
Mall
MAXWELL
MANNING
MOORE INC
TRADE MARK
EVINRUDE MOTORS
CONVAIR
Onan
ELECTRIC PLANTS
REED-PRENTICE CORP.
BOLENS HUSKI
fmc
Jacobsen
HYSTER
TOWMOTOR
ARO
Scott-Atwater
MERCURY
Automatic
ELECTRIC TRUCKS
BARBER COLMAN
KOHLER ENGINES
MERCURY
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POWER PRODUCTS
REO
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BUDA
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KAISER
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CLINTON
GEROTOR
OLIVER
MILLERS FALLS TOOLS
SINCE 1868
MM
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LOMBARD
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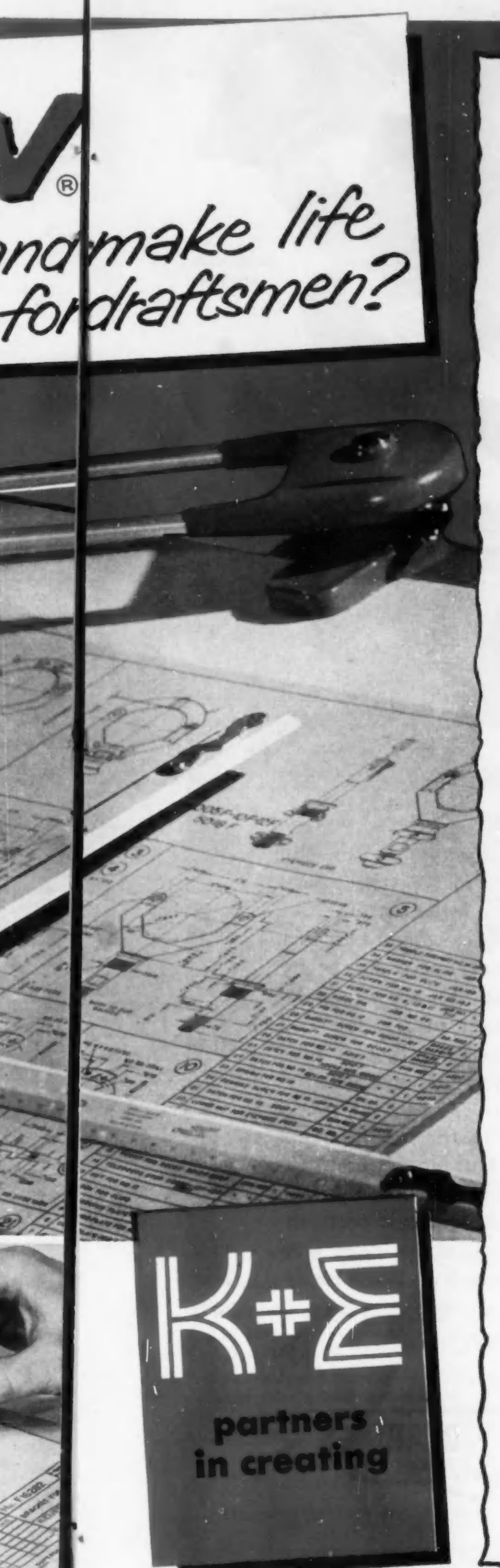
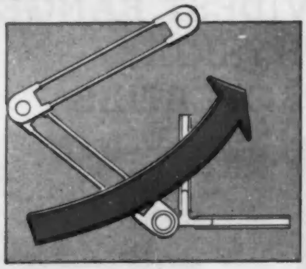
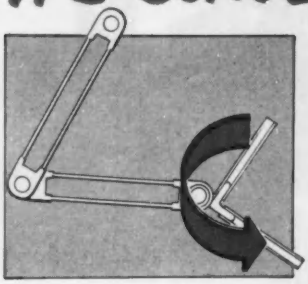


Because it's FAST

The Paragon Drafting Machine operates on the basic parallelogram principle. Three drums of precisely equal diameter are fitted with non-slipping bands. Top drum is fixed so that it cannot turn. Wherever you move the Paragon over the entire working area, you can draw precisely parallel lines: horizontal, vertical, or at any angle.



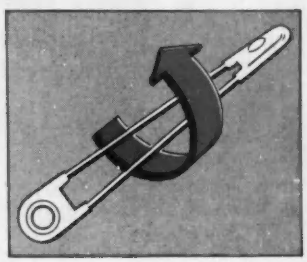
It's CONVENIENT



The Paragon is controlled entirely with your left hand, leaving your right hand free to draw. A slight pressure on the control ring gives you any common angle and its complement. All lines are drawn to exact length as you go, with no "tails" to erase later. When you're not using your Paragon, you simply park it out of the way on the anchor step.

It stays ACCURATE

Open-center arm construction, with no rigid center member, makes it practically impossible to disturb band length and factory-set tension. Even when the arms are twisted somewhat, as they must be when the head is lifted off the board, the dimensions of the rigid tubes and assembly remain unchanged. Scales continue to make exactly parallel lines straight out to the end.



It CUTS COSTS too

The Paragon eliminates hundreds of waste motions that the draftsman would have to make with hand equipment. It stays true and easy to operate throughout its entire life. It pays for itself in a matter of weeks, continues to cut costs over the years!

That's Why We Say . . .

IT'S QUICKER, EASIER, NEATER, WITH A PARAGON!

KEUFFEL & ESSER CO.

Est. 1867

NEW YORK, N. Y. HOBOKEN, N. J.

CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO • LOS ANGELES • MONTREAL

"They called it a hansom cab ...and I was its handsome driver"

"WHEN I CLIMBED up into the driver's seat of that old Wood's Electric, I was sitting on top of the world! This was their hansom cab and they called me their handsome driver. I was a contented man.

"We were never in a hurry, the Colonel, his wife, and I. They were very fine people; had a friendly way about them.

"When we went to the races, they insisted I remain on top of the car. Best seat at the track! And when we drove down Fifth Avenue on Easter morning, I had a perfect view of the parade. I saw everything clearly. Altho I couldn't help feeling rather important up there, the height was just right for me. You might say I had my head in the clouds, but my feet on the ground!"

(To draw a parallel, may we suggest that Automotive Color Stylists . . . creative men and women that they are . . . must also have their heads in the clouds, feet on the ground, the proper perspective, and an unclouded view at all times. To help maintain these obviously difficult demands, the Rinshed-Mason Company makes available to Automotive and other Industrial Color Stylists the consulting services of our own staff of Color Stylists and Technical Personnel. Feel free to call upon us at any time.)

The 1899 WOOD'S ELECTRIC HANSOM CAB, reproduced here, sold for $3050 when a dollar was worth five; offered a twenty-five-mile cruising range from one battery charge; top speed, 12 miles per hour.

Rinshed-Mason Co.

MANUFACTURERS of fine lacquers, enamels and undercoats for the products of industry.

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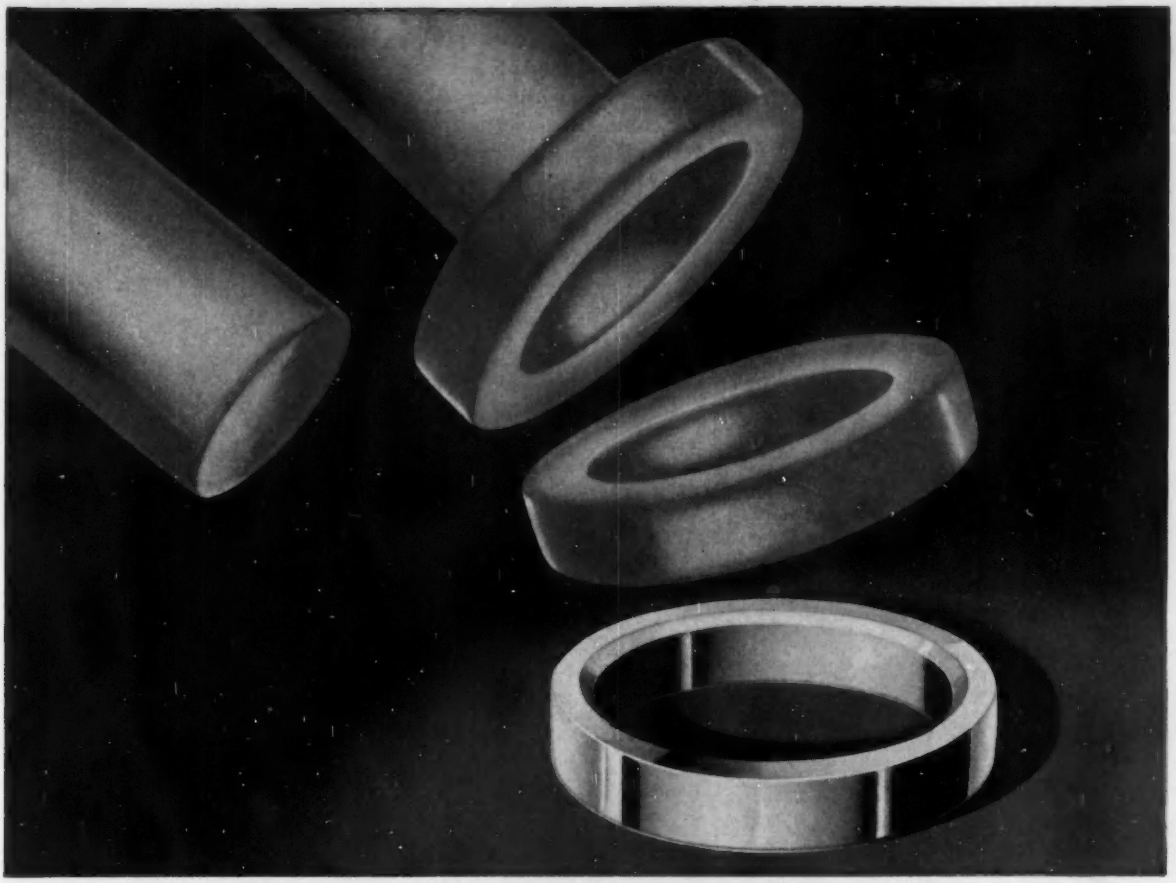
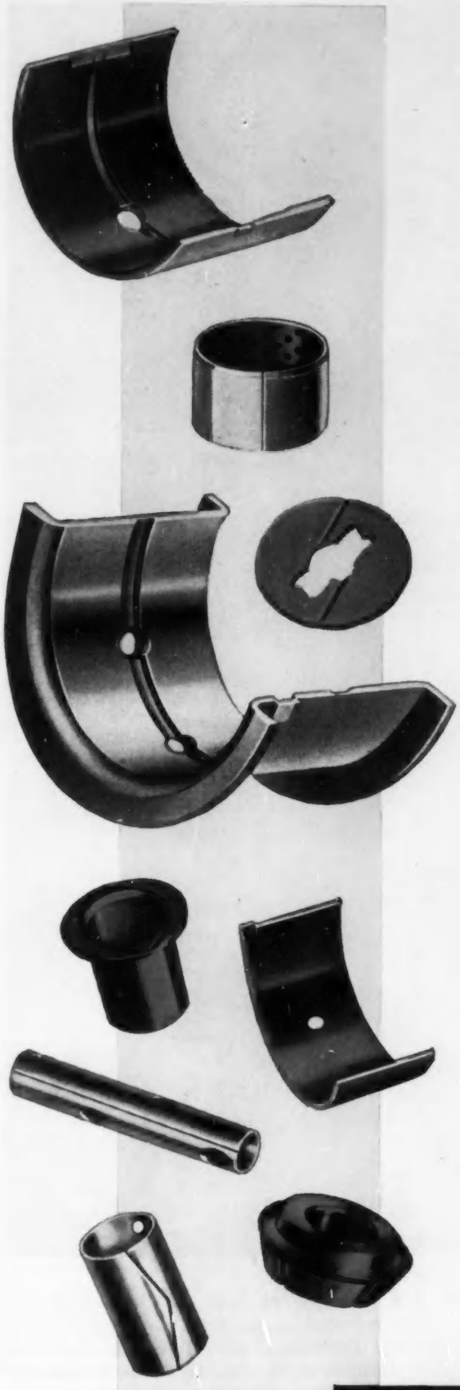
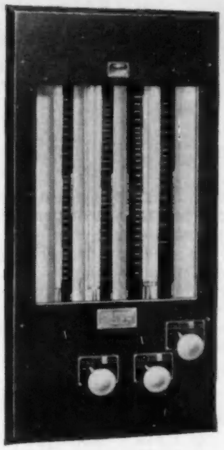
1244 North Lemon Street, Anaheim, California
In Canada • Rinshed-Mason Company of Canada, Ltd., Windsor, Ontario



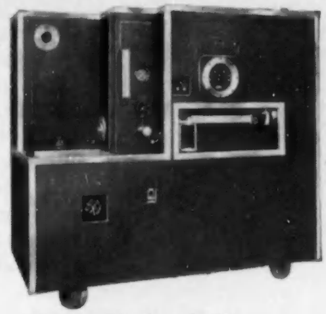


Cox Type 7
Direct Pressure Engine Indicator



Cox Type 12
Multiple Stage Flow-Meter

GOOD INSTRUMENTS ARE ALWAYS GOOD INVESTMENTS



Cox Type 309 Direct Weight
Method Flow-Meter Calibrating Stand

. . . and Making GOOD INSTRUMENTS Has Been Our Business For Over 40 Years

WHAT ARE *Your* TESTING PROBLEMS?

If your particular testing problem involves flow rate measurement or some similar phase of hydraulics requiring special equipment, we invite you to submit your problem to us for research and study. A description of the process involved and all pertinent specifications should be included. If in the opinion of our hydraulics engineers the basic idea is practical, we will undertake design and development of the special equipment.

DESIGNING and building Cox Precision instruments has been the full time job of Commercial Research Laboratories, Inc. for over *40 years.*

The experience and specialized "know-how" we have gained is evident in the great number of Cox instruments currently being used by the automotive and aircraft industries, and by the U.S. Airforce, Army, and Navy.

Today, as in the past, scientists and craftsmen here at Commercial Research Laboratories are hard at work developing new and improved Flow-Meters, Flow-Meter Calibrating Stands, Fuel Nozzle test stands, and other Cox precision testing devices to help you in meeting tomorrow's testing problems. At the same time, we stand ready to help in designing and building the accurate precision instruments your *immediate* testing problems require — whether for the research laboratory or the production line.

An example of modern CRL service is a flowmeter service department which we have just created. Using Cox Calibrating Stands, we are able to test any make or capacity flowmeter to determine to what *exact* percentage the instrument is accurate. In cases where design of the instrument will not allow re-calibration, correction curves can be supplied to guide users in future operation of the instrument.

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

MAKERS OF COX INSTRUMENTS REGISTERED TRADE MARK *SINCE 1912:* SINGLE AND MULTIPLE STAGE FLOWMETERS • FLOWMETER CALIBRATING STANDS • CARBURETOR FLOW STANDS • FUEL NOZZLE TEST STANDS • ENGINE INDICATORS • MAGNETIC THICKNESS GAGES • VIBRATION RECORDING EQUIPMENT
BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS.


25 leading engine builders use
Sealed Power Chrome Rings
Sealed Power Chrome-Faced top compression rings have made enviable records both for original equipment and in Sealed Power KromeX Ring Sets for replacement
Chrome-faced side rails on the Sealed Power MD-50 Steel Oil Ring contribute to the long wear of Sealed Power KromeX Ring Sets for replacement
SEALED POWER PISTON RINGS
Sealed Power Corporation
MUSKEGON, MICHIGAN
Sole manufacturers of KromeX Ring Sets, MD-50 Steel Oil Ring, Full-Flow Spring, Flex-S Flexible Oil Ring, and GI-60 Groove Inserts. Leading producer of Automatic Transmission Rings, Power Steering Rings, and Non-Spin Oil Rings.

Payload...75 Tons

World's largest truck uses MIEHLE-DEXTER SUPERCHARGERS

Dumping 75 tons of sand . . . or hauling copper ore up 18% grades from pit to crusher—that's the every-day job of these giant M-D supercharged trucks used by an Arizona open-pit copper mine.

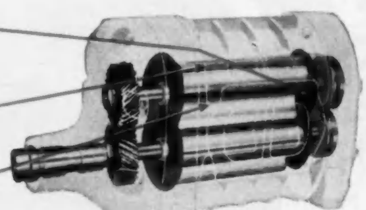
...moves more material faster at lower cost!

It takes *supercharged* power to haul a load like this! When Buda Diesels were selected to power the world's biggest truck, they made *sure* of *plenty of power* with Miehle-Dexter Superchargers. Buda's experience is typical. They find that simply adding an M-D Supercharger to their engines *boosts horsepower as much as 50% or more!* What's more, weight per horsepower is decreased. Little wonder that Miehle-Dexter Superchargers are found on so many of the country's leading Diesel engines.

You, too, can keep pace with the race for more horsepower by using M-D superchargers on your engines. The investment is usually far less than required by other methods. Write for bulletin.

Only MIEHLE-DEXTER gives you all these features!

- Internal construction uses patented rubber end plate seals. Eliminates metal contact, assures longer life, achieves fuel savings.
- Special wear strips on rotors eliminate metal-to-metal contact, assure longer wear.
- Lightweight aluminum rotors and housing boost power without adding weight.
- Standardized parts allow easy field service.



MIEHLE-DEXTER SUPERCHARGER

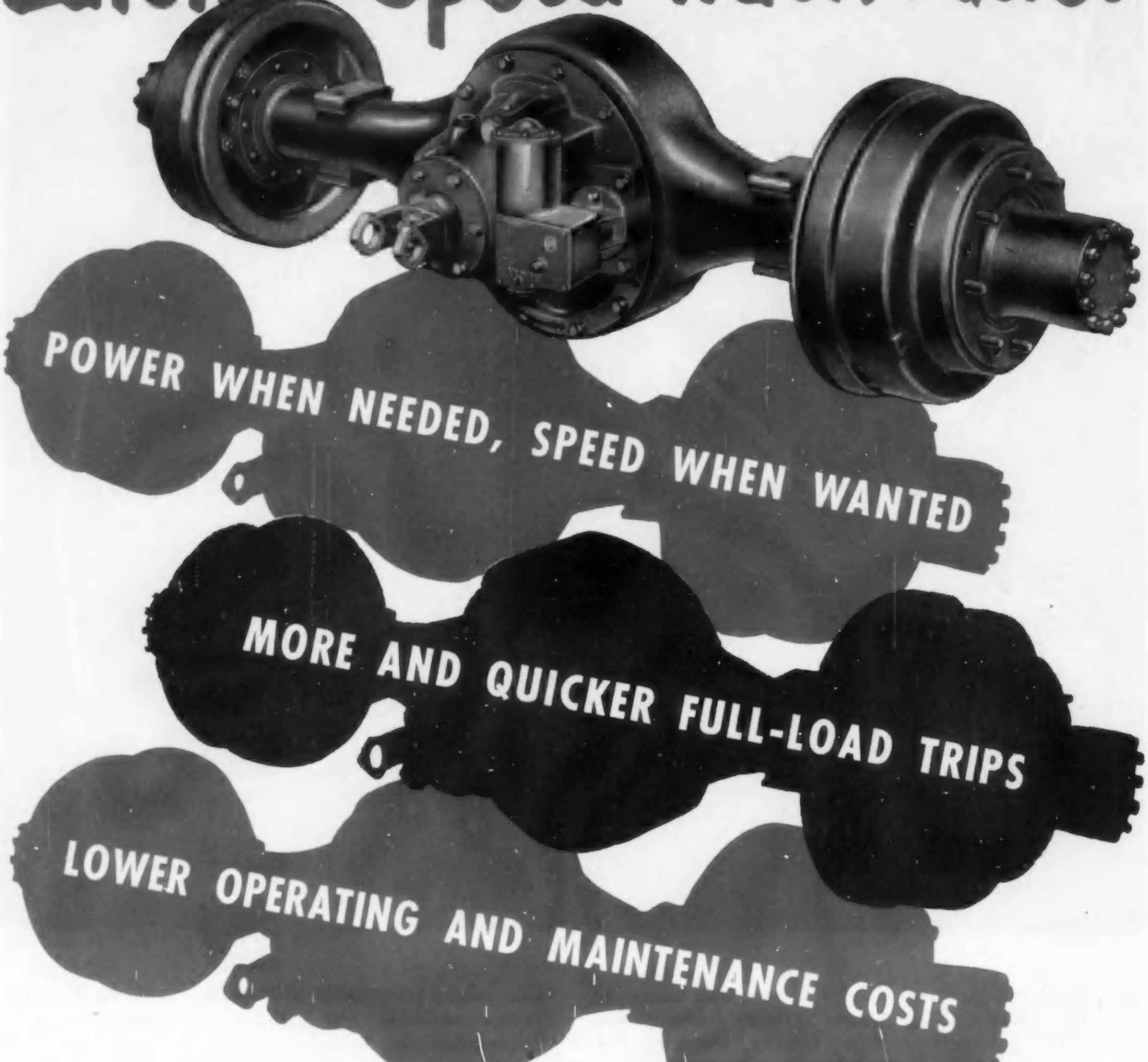
DIVISION OF THE DEXTER FOLDER COMPANY

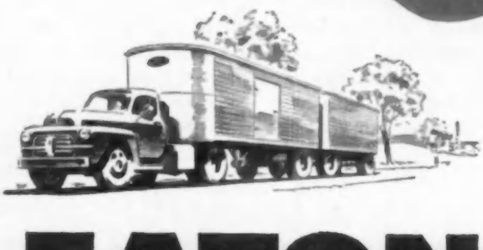
102 Fourth Street • Racine, Wisconsin

Trust M-D Superchargers for internal combustion engines . . . use them for blower and air compressor operations, too.

THE NEWS

Eaton 2-Speed Truck Axles





More than two million
Eaton Axles in trucks today!

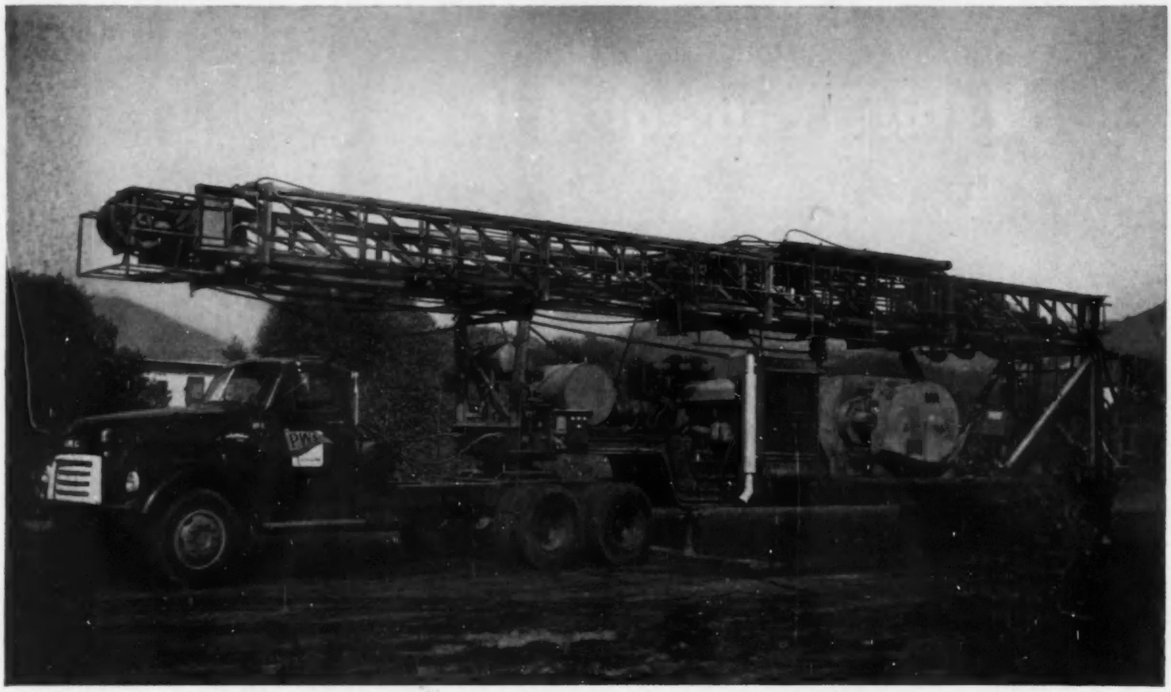
EATON

AXLE DIVISION

MANUFACTURING COMPANY

CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



Utility uses Mayari R steel for trailer underframes to cut down deadweight in heavy-duty units like this one. The mast on the rig, built by Wagner-Morehouse Co., is also made of Mayari R to give it the strength needed to withstand the terrific shocks incurred in tough oil drilling service.

24-Ton Oil Rig rides to work on bed of Mayari R

They build them really husky in the shops of Utility Trailer Manufacturing Co., in Los Angeles. Husky enough to carry weights in excess of 90 tons, including dump bodies and heavy industrial and construction equipment.

The special-bed trailer that totes the 35-foot-long portable oil well servicing rig, shown above, is typical of Utility design and manufacture. Its frame of Mayari R is its sturdy backbone. Utility, like other manufacturers, has found that Mayari R high-strength steel builds a frame that meets truckers' competitive needs without exceeding established highway axle load limits.

With a yield point 50 pct greater than that of structural-grade carbon steel, Mayari R can be used in lighter sections to bring down deadweight. Or it can be used in the same weight as carbon steel to provide greatly increased capacity for the vehicle. Either way, it cuts the cost of transporting freight, and brings in more revenue for operators.

Mayari R has five to six times the atmospheric-corrosion resistance of carbon steels, and holds paint 20 to 80 pct longer, depending on the type of paint used. It can be worked with the same equipment and methods as plain carbon steel.

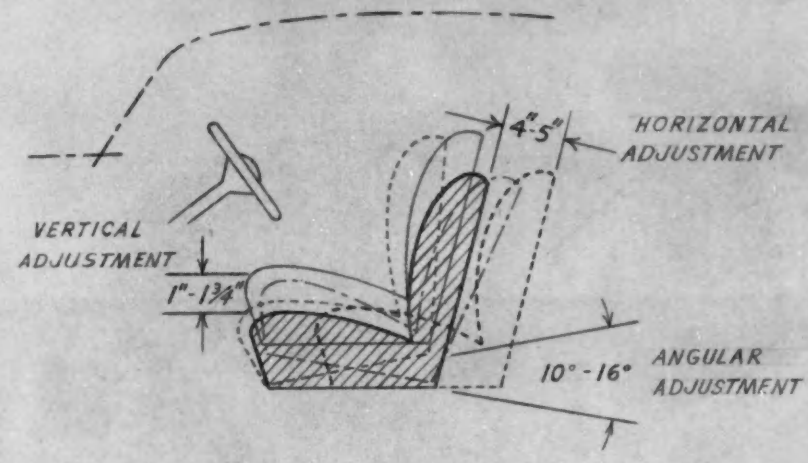
You can get more information on versatile weight-saving Mayari R from our Catalog 353. Write or phone the nearest Bethlehem sales office for a copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Mayari R makes it lighter...stronger...longer lasting



SKETCH OF DESIRED MOVEMENT

IN PROPOSED UNIVERSAL POSITIONING SEAT TRACK


BOEING B-52


IF IT'S PETROLEUM-POWERED
there's a Globe-built battery ... right from the start
GLOBE
Because contractors measure fast, sure starts in dollars...
KOEHRING uses GLOBE
batteries for these Dumptors
. . . and that's important news to makers of automotive equipment
Perhaps you've never seen and heard a Koehring Dumptor or shovel roar into action at the beginning of the day. It's truly an impressive experience.
Impressive, too, is the unfailing dependability of the Globe-built batteries used in these rigs. Regardless of the temperature or the fact that the machines may have been standing idle over the week-end . . . their Globe batteries have plenty of dependable reserve power to keep "spinning" the engine until it catches.
Likewise, Globe automotive batteries are also exceptionally dependable. They should be. They are the result of Globe's wide experience in building batteries for use where performance can be actually measured in dollars and cents.
Therefore, when you sell equipment with Globe batteries, *you* can be sure it's right from the start. What's more, *your* customers can be sure they're getting nothing but the best.
KOEHRING
GLOBE-UNION INC.
MILWAUKEE 1, WISCONSIN
GLOBE BATTERY PLANTS ARE LOCATED AT:
ATLANTA, GA. • BOSTON, MASS. • CINCINNATI, OHIO • DALLAS, TEXAS • EMPORIA, KANSAS • HASTINGS-ON-HUDSON, N. Y. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • MEMPHIS, TENN. • MILWAUKEE, WIS. • MINERAL RIDGE, OHIO • OREGON CITY, ORE. • PHILADELPHIA, PA. • REIDSVILLE, N. C.

HYDRAULICS FOR MOBILE EQUIPMENT

Mobile Equipment News

IMPROVES PERFORMANCE • CUTS COSTS

VOL. 2 — VICKERS INCORPORATED, DETROIT, MICHIGAN — NO. 4

VICKERS® VT16 PUMP NOW AVAILABLE FOR HYDRAULIC POWER STEERING OF TRUCKS AND MATERIALS HANDLING VEHICLES

The Vickers Series VT16 pump is used more widely than all other makes combined for the power steering of automobiles. It is now available for the first time for the hydraulic power steering of trucks and materials handling vehicles. It has all the characteristics important to this service and is used in a separate hydraulic circuit for steering only.

COMPLETE PACKAGE

Series VT16 has integral volume control valve and relief valve . . . also an integral oil reservoir. This is a complete hydraulic power package for steering.

SIMPLIFIED INSTALLATION

This compact and complete power package is easily and quickly installed. All you need to do is bolt it on, make two hydraulic connections, and couple the power.

LONGER PUMP LIFE

The exclusive Vickers "Hydraulic Balance" eliminates pressure-induced bearing loads and the consequent wear. These lighter bearing loads mean much longer bearing and pump life.

NO LOAD STARTING

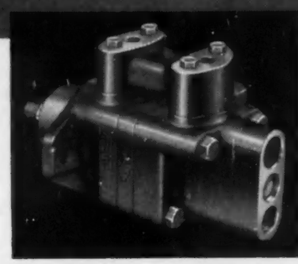
At rest and normal starting speeds, the sliding vanes are retracted; only after engine fires do vanes extend and pumping begin.

ASK FOR BULLETIN M-5104A

Series VT16 Vickers Pump with integral volume control and relief valves and oil reservoir. For hydraulic power steering.

HIGH OPERATING EFFICIENCY

The vane type construction, hydraulic balance and automatic maintenance of optimum running clearances enable these pumps to deliver more oil with less power. This high operating efficiency is maintained throughout the long pump life.



Series VT17 Vickers Pump is similar to the VT 16 except that it does not include the oil reservoir.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1440 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA (Metropolitan) • PITTSBURGH • ROCHESTER • ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER

VICKERS® HYDRAULIC POWER STEERING BOOSTER

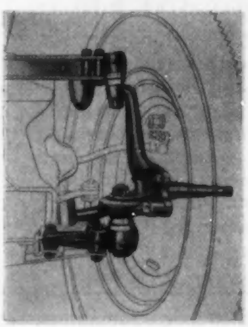
EFFORTLESS • POSITIVE • SHOCKLESS

6726

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921


SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Bronze ball retainer . . . 48 sizes ½" to 3½" I.D.
C SERIES • Light duty, one direction ball thrust bearing. Flat seat. Flat races. Pressed steel retainer . . . 16 sizes ½" to 1⁷⁄₁₆" I.D.
P SERIES • Light duty, one direction thrust bearing. Flat seat. Grooved races. Pressed steel retainer . . . 43 sizes ½" to 3½" I.D.
G SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 76 sizes ½" to 7⅜" I.D.
E SERIES • Medium duty ball thrust bearing. Banded. Flat seat. Grooved races. Full complement of balls . . . 40 sizes ½" to 3½" I.D.
1000 SERIES • Light duty ball thrust bearing. Flat seat. Grooved races. Pressed steel retainer. Metric standard . . . 36 sizes 10 to 125 mm. I.D.
1100 SERIES • Medium duty ball thrust bearing. Grooved races. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.
1400 SERIES • Medium duty. Grooved races. Spherical seat. Pressed steel or bronze (large sizes) retainer . . . 23 metric sizes 10 to 140 mm. I.D.
W SERIES • Case hardened and ground flat washers for various Thrust and Spacer applications. Slip fit. 38 sizes ½" to 3½" I.D.
R SERIES • Ball thrust retainer. One piece, pressed steel, channel type cage . . . 79 inch sizes 0.266" to 4.232" I.D.
Judged by every quality and performance standard Aetna bearings measure up to modern industry's increasingly exacting needs. That's why Aetna has a customer list that reads like Who's Who in American Industry—why 80% of Aetna's business comes from firms it has served for 20 or more years. Aetna has specialized on the advanced development, production and application of high precision anti-friction products for nearly four decades. Be sure to give this valuable background of experience your serious consideration when planning improvements of your present products or developing new ones for future production. We welcome your inquiry.
AETNA BALL & ROLLER BEARING CO. U.S. PAT.
SEE THAT NAME? IT STANDS FOR
BEARINGS
AT THEIR
BEST
CLUTCH BEARINGS • Ball thrust clutch release bearing. Banded. Pre-lubricated, T-type, oil impregnated bronze retainer assures concentricity and smooth, quiet, long-life performance.
Aetna
Precision Bearings and Parts for Every Branch of Industry
AETNA BALL AND ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION
4600 SCHUBERT AVENUE
CHICAGO 39, ILLINOIS
SPECIAL BEARINGS • Facilities for sizes up to 38" O.D. Counsel that brings you the expert technical aid that has licked many of industry's toughest bearing application problems.
PRECISION PARTS • Aetna is versatile—can mass-produce vital parts in almost limitless sizes and shapes—to your most exacting metallurgical, tolerance and finish specifications.
Write for latest catalog. Contains specifications on Aetna's complete line—vital technical reference data on bearing selection, load capacities, lubrication, care and maintenance.

Why did Ford adopt Ball-Joint Front Suspension?



Because with more horsepower you need greater stability, easier steerability!

...and that's not all

The growing trend towards increased engine output places a greater emphasis on easier, safer steering and over-all stability. That's why Thompson's front suspension ball-joints . . . *the first major development in front wheel suspension in 20 years* . . . are incorporated into the latest model Ford.

Other Advantages, Too

There are five *additional* automotive problems solved by ball-joint front suspension: Creating new space for wide modern engine design • Eliminating front suspension and steering bind • Cutting front end overhaul time *by hours* • Reducing lubrication points from 12 to 4 • Increasing service life *many times over.*

Half-Century of Teamwork

This Thompson "Engineered Steering" development is a typical example of Thompson's side-by-side cooperation with the Automotive Industry over the past 50 years.

Yours for the Asking

If you have a steering linkage problem you'd like to discuss with Thompson's skilled and experienced Steering-Linkage Engineers, write, phone or wire Thompson Products, Inc., Michigan Plant, 7881 Conant Avenue, Detroit 11, Michigan.

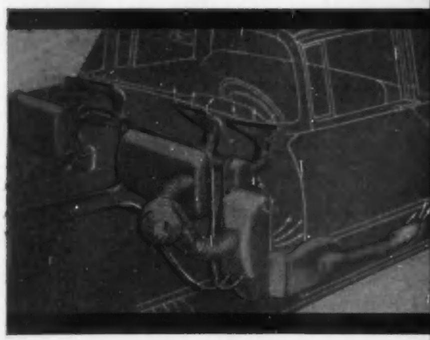
You can count on

Thompson Products

MICHIGAN PLANT: • DETROIT • FRUITPORT • PORTLAND

TEMPERATURES MADE TO ORDER

Cools the Powerglides! This light-weight, space-saving Harrison oil cooler has been a fixture on every Chevrolet torque transmission built!



New Cadillac Automatic Heating System by Harrison. Features two blowers and four heat outlets—two in front and two in the rear.

It's all a matter of degrees! Hot or cold—wherever temperature is a factor—chances are, Harrison is on the job! For Harrison Radiator Division is the world's largest manufacturer of temperature control systems for automobiles. In itself, this leadership is proof of Harrison quality. Harrison heat transfer products are efficient and durable—designed to save space, save weight, save money, too. With extensive research facilities—hot tunnels, cold tunnels and modern testing equipment—Harrison is constantly searching for *and finding* better ways to build radiators, heaters, defrosters and air conditioners. If you have a hot or cold problem . . . look to Harrison for the answer!

HARRISON

RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N. Y.


NEWER
Than Nuclear Fission !
METERED STEEL REACTOR
Now Allows You To Specify Your Own Piston Clearance!
with
STERLING
CONFORMATIC*
PISTONS
Tests now prove that by varying the strength and design of the steel insert we can pre-determine piston skirt expansion and contraction to meet any engine clearance specification . . .
CONSTANT CLEARANCE over the entire temperature range from −20° F. to 200° F. Closer clearances than ever before possible without danger of scuffing or seizing.
STERLING ALUMINUM PRODUCTS INC., SAINT LOUIS, MISSOURI

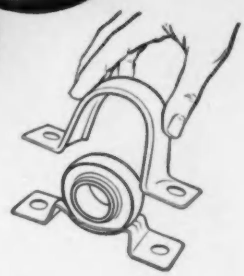
+ INDEX TO ADVERTISERS +


They're pouring *futures* in the foundry !
When man first cast molten metal, he poured himself a future. He started something that has become more and more important – a process our great industries could not do without. The results are everywhere. You'll find castings used again and again in a multitude of applications. They're on the *horizon,* too . . . clearly marked for the products of tomorrow.
Helping push this progress in the foundry is Campbell, Wyant and Cannon. From the cupolas, electric furnaces, and converters of CWC flow metals with a background based on new ideas, new processes, new methods in casting techniques. Not content with producing the best of today's castings, the engineers of CWC are already planning the things to come. Remember, for all that's new in castings, keep your eye on Campbell, Wyant and Cannon.
CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY
Muskegon, Michigan
CWC
Since 1908

ANOTHER NEW FAFNIR...

Ball Bearing

"Economy Package"



Type PB
Pressed Steel
Pillow Block

The new Type PB Series Pillow Block is developed to fill a specific need for a high-quality, precision ball bearing unit at the lowest possible cost. It is made for *light duty* applications where a low-cost "packaged" unit offers definite manufacturing and servicing advantages . . . on agricultural equipment, conveyors, light-duty fans and similar types of machinery involving the transmission of power.

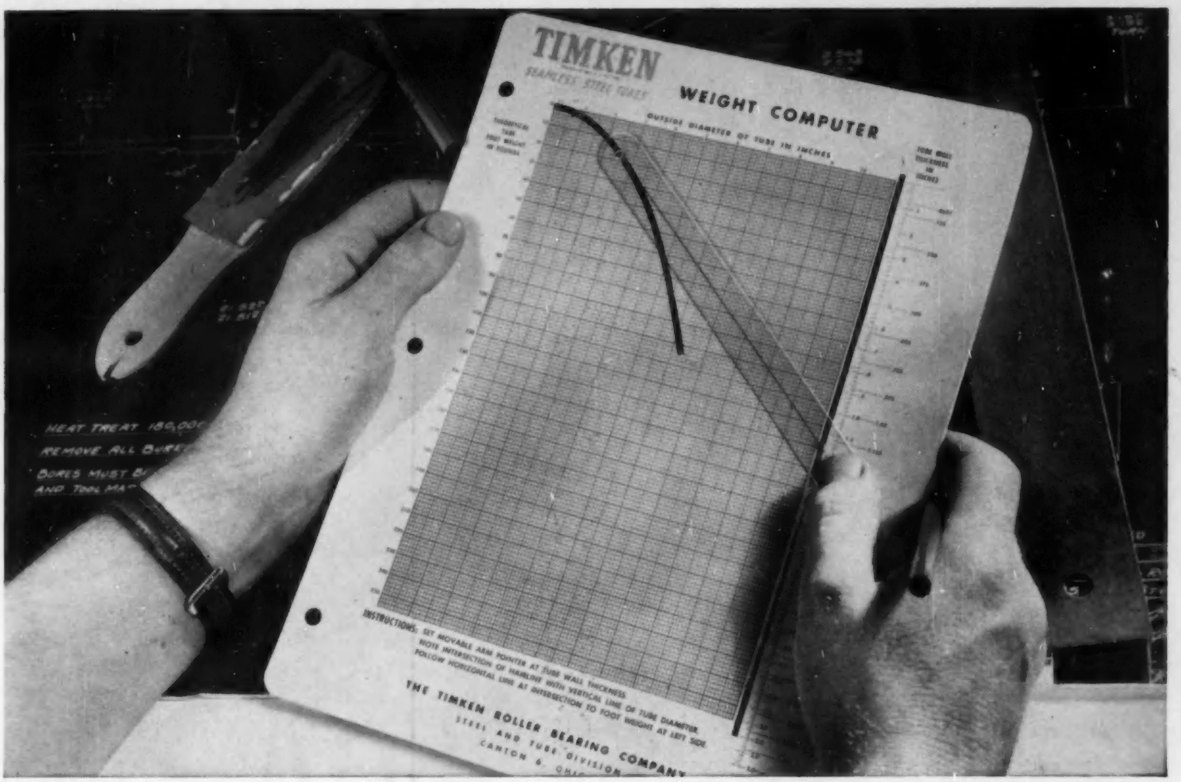
The Type PB Series Pillow Block opens up new opportunities to add extra product sales features and to lower maintenance costs . . . another example of the Fafnir "attitude and aptitude". Send for new, descriptive bulletin. The Fafnir Bearing Company, New Britain, Conn.

OUTSTANDING FEATURES

- Low Cost
- Precision Ball Bearing . . . Fafnir Wide Inner Ring Bearing* with Self-locking Collar and efficient Plya-Seals.
- Two-piece separable pressed-steel housing.
- Self-aligning . . . unrestricted in all directions at assembly.
- Occupies less space than other pillow blocks.
- Light weight . . . combined with ample strength.
- Only two bolt holes required in assembly.
- Ample capacity for radial, thrust or combined loads.
- Pre-lubricated with long-life grease.
- Available for shaft sizes ½" to 1¼" inclusive.

*Easiest bearing of all to install. Counterbored, eccentric, mated cam construction of collar and inner ring assures positive locking action without set screws, lock nuts or adapters.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



This free computer quickly figures the weight of steel tubing

WITH this handy little computer, you can quickly figure the weight of steel tubing. You set the slide at tube-wall thickness and O.D. and simply read off the tube weight per foot. Write us and we'll send you one. There's no obligation, of course.

This computer is a small example of the helpful service the Timken Company offers manufacturers of hollow steel parts. Even more important: our engineers will be glad to study your problem and recommend the most economical tube size, *guaranteed* to clean up to your dimensions.

Many companies that formerly used bar stock for their hollow parts are making significant savings because they switched to Timken® seamless tubing. In addition to the big reduction in scrap loss, they save a great deal of machining time. Frequently, finish boring is the first production step. Machine tools are released for other jobs.

Timken seamless tubing has fine forged quality because it is made by a piercing process which is basically a forging operation. Write us now on your company letterhead for the handy tube weight computer. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING